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Adjacent Store Effects, Hysteresis Effects, and Comparison with Flight Test of 1/20 Scale A-10 Aircraft Wind Tunnel Test Data

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AIRCRAFT COMPATIBILITY BRANCH
MUNITIONS DIVISION

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An investigation is made into adjacent store effects of representative store and store loadings on the 1/20 scale A-10 aircraft wind tunnel model. Hysteresis effects during testing and comparison of wind tunnel data with full scale flight test results are presented. Data were obtained at Mach numbers 0.30, 0.50, 0.65, and 0.75. Angles of attack tested were 0^o, 5^o, 10^o, 15^o, and 20^o with angles of sideslip ranging from -18^o to $+18^o$. The study is based on wind tunnel tests conducted at Arnold Engineering Development Center in 1978 and on flight tests conducted during 1977 at Edwards Air Force Base.

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PREFACE

This study was conducted by the Munitions Division, U.S. Air Force Armament Laboratory, Armament Division, Eglin Air Force Base, Florida during the period November 1979 to March 1980 under the A-10 Implementation Plan. Dr. Lawrence Lijewski was program manager.

The Public Affairs Office has reviewed this report, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

BARNES E. HOLDER, JR., Colonel, USAF
Chief, Munitions Division

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LIST OF ABBREVIATIONS, ACRONYMS, AND SYMBOLS

Alpha, α	Angle of attack (positive nose up)
AR	Abrupt Rudder Maneuver
Beta, β	Angle of sideslip (positive nose left)
BL	Butt line location (inches)
CA_{EST}	Estimated axial force coefficient (positive aft)
CLL	Roll Moment Coefficient (positive clockwise looking forward)
CLN	Yawing Moment Coefficient (positive nose right)
CM	Pitching Moment Coefficient (positive nose up)
CN	Normal Force Coefficient (positive up)
CY	Yaw Force Coefficient (positive right)
d_1	Vertical distance between the store centerline or multiple store configuration reference line and the flight reference Y-axis (inches)
d_2	Horizontal distance between forward suspension point and flight reference Z-axis (inches)
d_{FLT}	Reference length, flight test (feet)
d_{WT}	Reference length, wind tunnel test (feet)
FLT	Flight Test
FS	Fuselage station (inches)
MER	Multiple Ejection Rack (6 stores)
MSER	Multiple Store Ejection Rack (4 stores)
μ	Population mean
N	Number of samples
P	Freestream Static Pressure (psfa)
PT	Freestream Total Pressure (psfa)
Q	Freestream Dynamic Pressure (psfa)
RN	Reynolds Number (per foot)

LIST OF ABBREVIATIONS, ACRONYMS, AND SYMBOLS (CONCLUDED)

SPU — Symmetrical Pull-up Maneuver

SSS — Steady-State Sideslip Maneuver

S_{FLT} — Reference area, flight test (ft^2)

σ — Standard Deviation

S_{WT} — Reference area, wind tunnel test (ft^2)

t — Statistical factor defined by the equation for the normal curve:

$$y = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2} t^2}$$

TER — Triple Ejection Rack (3 stores)

TRL — Triple Rail Launcher (3 stores)

TT — Freestream Total Temperature (^{o}F)

(U) — Unfinned

WL — Water line station (inches)

WTT — Wind Tunnel Test

$\bar{X}$ — Sample average

XMR — Horizontal distance between forward suspension point and most forward point of store configuration (inches)

YB — Coefficient value at a given X for the main pylon store configuration

YDIFF — Y difference between two data curves at a given X

ZMR — Vertical distance between store configuration centerline and pylon lower surface (inches)

SECTION I

INTRODUCTION

Carriage airloads wind tunnel testing is becoming more and more costly with the rising price of electric power. To reduce these costs to a minimum, more efficient testing procedures must be explored. The purpose of this effort is to investigate the feasibility of these procedures as pertaining to the A-10 aircraft. One method is small scale testing in relatively small wind tunnels. For a number of years the Air Force Armament Laboratory (AFATL) has pursued this concept with much success. One-twentieth scale models of the F-15 and F-16 aircraft have been extensively tested in the 4-foot transonic wind tunnel at Arnold Engineering Development Center (AEDC) and the results compared with larger scale model results (References 1 and 2). Good results have verified the feasibility of the 5% model testing technique. This present work assumes the validity of the 5% model technique and explores the agreement of the wind tunnel data with flight data. A second method is the pitch-pause method of taking airloads wind tunnel data. By taking alpha or beta sweep airloads data with the pitch-pause technique, minimum time occurs between data points thus reducing overall test time. To assure this technique is valid for the A-10, hysteresis testing is conducted to determine flowfield lag effects around the aircraft. Testing is then accomplished in such a way as to eliminate any hysteresis effects. A third technique to reduce test costs is adjacent pylon testing of stores. If stores can be tested on adjacent pylons without mutual interference, the maximum number of stores per configuration can be increased. This reduces the number of configurations and thus test costs. The present work investigates 54 different adjacent store effects combinations on the A-10 aircraft, ranging from small and large single carriage stores to multiple store cases with different ejector racks.

SECTION II

TEST SUMMARY

This section summarizes the wind tunnel and flight tests with regard to test conditions, configurations, data uncertainty, and stores tested. The wind tunnel test was conducted at AEDC in the 4-foot transonic tunnel (Reference 3), and included approximately 70 hours of testing during the period 26 May through 3 June 1978. The flight test conducted during 1977 at Edwards AFB, California, included 17 configurations of which 6 configurations are presented for comparison.

2.1 Wind Tunnel Test (Reference 4)

2.1.1 Test Conditions

The wind tunnel test was conducted to measure loads on stores mounted in the carriage position on a 0.05-scale model of the A-10 aircraft. Six of the 11 A-10 pylons were equipped with internal strain-gage balances, each of which measured five-component force and moment data. Thirty-six configurations consisting of 15 different store models and four different loading racks mounted in various combinations on all 11 pylons were tested. Each configuration was tested at Mach numbers 0.3, 0.5, 0.65, and 0.75 at sideslip angles from -18 to 18 degrees for constant angles of attack of 0, 5, 10, 15, and 20 degrees. One symmetrical configuration (Configuration 30) was chosen to check for aerodynamic hysteresis effects. Table 1 lists the nominal test conditions.

2.1.2 Test Articles

The 0.05-scale A-10 model and its associated hardware dimensions and details are presented in Figures 1 and 2. The A-10 model has adjustable flaps, ailerons, speed brakes, elevators, and rudders; however, during this test all control surfaces were set to zero or the neutral position. Pylons 1, 3, 5, 6, 8, and 10 were equipped with balances (Figure 3). The balances were fixed in the pylons with screws and pins and remained on the aircraft during the entire test. The remaining dummy pylons (2, 4, 7, 9, and 11) were also affixed to the aircraft at all times. The 0.05-inch gap (Figure 2) between the store and pylons that was present on the metric pylons was simulated on all dummy stores and racks with 0.05-inch-thick spacers at the attachment points. Details and dimensions of the external stores and racks are shown in Figure 3. Figure 4 provides a key by which the various configurations are identified. Table 2 and Figure 5 indicate the reference dimensions and moment reference points for all store configurations.

2.1.3 Test Instrumentation

Test instrumentation consisted of five-component carriage load balances within pylons 1, 3, 5, 6, 8, and 10 and an angular position indicator (API) for measuring the model attitude. The carriage load balances are an integral part of the pylons, and the loading racks or stores mount directly to the balance such that the balance measures the loads transmitted to the pylon by the rack or store. Because of space constraints, axial-force links could not be incorporated into the carriage load balances; and hence, axial-force loads of the various store configurations could not be determined. The API consists of a strain gaged pendulum, encased in oil to damp out unwanted vibrations, that delivers an output proportional to model attitude. In this case, the model was not only pitched but also rolled; and hence, the API was calibrated over a range from -20 to 20 degrees in pitch and from -180 to 180 degrees in roll.

TABLE 1. SUMMARY OF NOMINAL TEST CONDITIONS

MACH	PT	Q	P	TT	RN x 10^{-6}
0.30	2000	118	1879	89	1.80
0.50	1200	177	1012	83	1.70
0.65	1200	267	903	83	2.06
0.75	1200	325	826	84	2.25

TABLE 2. WIND TUNNEL TEST REFERENCE DIMENSIONS AND MOMENT REFERENCE POINTS

STORE	PYLON	RACK*	XMR	ZMR	S_{WT}	d_{wt}	CA_{EST}**
AGM-65	3	TRL	2.725	0.3500	0.007963	0.10069	
ALQ-119-12	1	-	4.800	0.3000	0.00196	0.0500	
ALQ-131(AB)	1	-	5.590	0.3850	0.00196	0.0500	
BLU-1(U)	8,10	-	3.225	0.5187	0.00479	0.0781	0.096
GBU-8/B	8	-	3.974	0.5000	0.00442	0.0750	
GBU-10(C/B)	3,5,8	-	5.060	0.5000	0.00442	0.0750	
GBU-12(B/B)	1,8	-	3.960	0.3188	0.00158	0.0448	
GBU-15(CWW)	3	-	4.251	0.5000	0.00442	0.0750	
GBU-15(PWW)	3	-	4.251	0.5000	0.00442	0.0750	
LAU-68	8	TER	1.610	1.0225	0.007006	0.09445	
MK-20	1	-	2.201	0.3819	0.00240	0.0553	
MK-20	8	MSER	4.552	0.8519	0.007175	0.09558	
MK-20	8	TER	2.201	1.1060	0.010186	0.113882	
MK-82(GP)	1,3,5,10	-	1.910	0.3188	0.00158	0.0448	0.152
MK-82(GP)	5	MSER	4.261	0.7888	0.005535	0.08395	
MK-82(GP)	8	TER	1.910	1.0438	0.007726	0.09918	
MK-82(SE)	5	TER	1.910	1.0438	0.007726	0.09918	
600-GALLON	6,8	-	7.725	0.7980	0.01287	0.1280	0.143
SUU-30(H/B)	1,5,10	-	2.050	0.4530	0.00354	0.0672	0.464
SUU-30(H/B)	3,8	TER	2.050	1.1780	0.01361	0.13162	
SUU-30(H/B)	5,6,8	MSER	4.401	0.9230	0.009455	0.10972	
SUU-30(H/B)	6	MER	4.468	1.1780	0.01361	0.13162	0.464

*Dashes denote single store

**Data not calculated for these configurations where not included

Notes: 1. XMR measures from nose of forward store when mounted on rack.

2. ZMR measured from centerline of lowest store when mounted on rack.

2.1.4 Data Uncertainty

The balance and instrumentation system uncertainties, based on a 95-percent confidence level, were combined with the uncertainties in the tunnel parameters, using a Taylor series approximation for error propagation, to estimate the uncertainties of the tunnel parameters and the aerodynamic coefficients. Representative uncertainties determined in tunnel parameters and aerodynamic coefficients are given in Table 3. The calculations shown are for the 600-gallon ferrying tank mounted on pylon 6. The balance calibration uncertainties were approximately the same for all balances; hence, when reference areas and lengths are accounted for, the coefficient uncertainties shown are typical of all store and balance combinations. The precision in setting and maintaining a specific Mach number was ±0.005. The uncertainty in model angle of attack was ±0.1 and in model roll angle was ±0.4 degree. These coefficient uncertainties are used in the data curve difference analyses in both the hysteresis effects study (Section III) and in the adjacent store effects determination (Section IV).

2.1.5 Data Modifications

To allow direct comparison of wind tunnel test and flight test data, the wind tunnel data were modified to agree with the flight data with respect to reference dimensions and moment reference centers. These changes were made only to the data used for comparison in Section V. The following equations were utilized along with dimensions from Tables 2 and 4 and Figure 6. The factors 400 and 8000 reflect the change from 1/20 scale to full scale models.

$$CN_{WT}\ (\text{new}) = CN_{WT}\ (\text{old}) * 400 * \left[\frac{S_{WT}}{S_{FLT}}\right] \tag{1}$$

$$CY_{WT}\ (\text{new}) = CY_{WT}\ (\text{old}) * 400 * \left[\frac{S_{WT}}{S_{FLT}}\right] \tag{2}$$

$$CM_{WT}\ (\text{new}) = CM_{WT}\ (\text{old}) * 8000 * \left[\frac{S_{WT}}{S_{FLT}}\right]\left[\frac{d_{WT}}{d_{FLT}}\right] + \frac{20}{12} * 0.23 * 400 * \left[\frac{CA_{EST}}{d_{FLT}}\right]\left[\frac{S_{WT}}{S_{FLT}}\right]$$

$$CLN_{WT}\ (\text{new}) = CLN_{WT}\ (\text{old}) * 8000 * \left[\frac{S_{WT}}{S_{FLT}}\right]\left[\frac{d_{WT}}{d_{FLT}}\right] + \left[\frac{d_1 + 1}{12}\right] * \left[\frac{CY_{FLT}}{d_{FLT}}\right]$$

TABLE 3. WIND TUNNEL TEST MEASUREMENT UNCERTAINTIES

DATA PARAMETER	MACH 0.30	0.50	0.65	0.75
	DATA UNCERTAINTIES			
MACH	±0.0077	±0.0066	±0.0054	±0.0049
PT	±4.3	±3.6	±3.6	±3.6
P	±4.3	±3.3	±3.1	±2.9
Q	±5.8	±4.3	±3.8	±3.5
CN (CN = 0)	±0.092	±0.061	±0.041	±0.033
CN (CN = 1)	±0.104	±0.066	±0.043	±0.035
CY (CY = 0)	±0.085	±0.057	±0.037	±0.031
CY (CY = 1)	±0.098	±0.061	±0.040	±0.033
CLM(CLM = 0)	±0.041	±0.027	±0.018	±0.015
CLM(CLM = 1)	±0.064	±0.037	±0.023	±0.018
CLN(CLN = 0)	±0.036	±0.024	±0.016	±0.013
CLN(CLN = 1)	±0.061	±0.034	±0.021	±0.017
CLL(CLL = 0)	±0.054	±0.036	±0.024	±0.020
CLL(CLL = 1)	±0.073	±0.043	±0.028	±0.022

Note: Uncertainties calculated at the test conditions listed in Table 1.

TABLE 4. FLIGHT TEST REFERENCE VALUES

STORE	S_{FLT}	d_{FLT}	d_1	d_2
MK-82	0.630	7.433	11.00	7.0
BLU-1	1.867	10.833	11.00	7.0
SUU-30	1.417	7.333	11.00	7.0
SUU-30 (MER)	8.502	7.333	10.53	15.0
600 Gallon Tank	5.034	24.917	10.53	15.0

CA_{EST} is an estimated axial force obtained from a freestream aerodynamic parameter prediction technique.

2.2 Flight Test (Reference 5)

2.2.1 Summary

A store loads flight program was conducted at Edwards Air Force Base, California with A-10A aircraft AF S/N 73-01664. The purpose of the flight program was to clear certain representative stores by demonstration to 100% store limit load factors within the flight envelope of the aircraft. In order to achieve this objective it was required to fly an 80% survey in order to verify the design limits prior to the 100% store limit load factor demonstration flights. The basic data measured were sway brace pin and attachment lug loads which were converted to store airloads and corresponding moments by a system of equations accounting for the distribution of forces and the inertia of the particular store being considered. Table 4 lists the flight test reference values used and Figure 6 illustrates the axis system employed in both the 80% and 100% load comparisons.

2.2.2 80% Survey

The 80% limit load survey was conducted in order to determine, by extrapolation of the accumulated data, whether the airplane was cleared to fly the 100% demonstration maneuvers. Extrapolated loads data, for each of the stores carried, were examined to determine whether they fell within the strength envelope of the particular pylon under consideration. The 80% limit load phase of the store loads program was a complete survey using basically stable and unstable stores at each pylon measuring station to evaluate the aerodynamic loading on the store for various angles of attack and sideslip conditions. These results give an indication as to the local flowfield about the store and served to verify the 100% design loads. In addition, the information gathered affords a means for predicting aerodynamic loadings on similar stores not tested during this program. The survey maneuvers consisted of symmetrical pullups, steady state sideslips, and bank to bank rolls. The symmetric maneuvers performed were designed to yield variations in aerodynamic loads with angle of attack, the rudder maneuvers with sideslip angle, and the rolling maneuvers for the combined effects of angle of attack and sideslip. The maneuvers were performed at altitudes of 7500 to 30,000 feet for a Mach number range of from 0.27 to 0.75.

Figure 7 presents the aircraft loading configurations investigated during the 80% survey.

2.2.3 100% Demonstration

The final phase of the store loads program was to demonstrate 100% store limit load factors, or 100% limit design store loads, whichever governed, for the particular store and location considered.

In some cases a low enough gross weight could not be achieved to demonstrate the full load factor capability of the store. For these cases the store was demonstrated to the load factor limited by the aircraft gross weight.

Figure 7 shows the test configurations (loadings) for this phase of the study which were determined by analyses to be critical for the design of the wing-pylon structure. In general, the MK-82 stores are designed for full aircraft roll capability which develops maximum sideload. Maximum vertical loads are developed by the heavy weight stores and maximum pitching and yawing moments are developed by the finless stores.

2.2.4 Flight Test Technique

The following subsections describe the flight techniques employed during the store loads flight test program. The maneuvers performed in both the 80% and 100% cases are discussed below.

a. Normal Symmetric Pullup

At the test altitude and speed, a relatively smooth symmetrical pullup was performed to obtain the required normal load factor.

b. Steady-State Sideslip

At the test altitude and airspeed, a level sideslip maneuver to maximum sideslip angle was performed by slowly deflecting the rudder, keeping the airplane at a wings-level flight attitude throughout the maneuver.

c. Abrupt Rudder Kick (100% Maneuvers Only)

At the required test altitude and airspeed an abrupt rudder kick was performed until dynamic overswing occurred and the airplane attained a steady sideslip angle. Once this was accomplished, the rudder pedal was returned to the neutral position.

d. Abrupt Rolling Pullout

At the test altitude and airspeed an abrupt rolling pullout was performed using the following procedure:

After establishing steady turn at a bank angle corresponding to the required test load factor, the airplane was rolled through an angle equal to twice the initial bank angle.

Aileron controls were abruptly applied until the roll rate built up to the prescribed allowable value for the particular store loading.

The roll was checked by applying abrupt lateral control to neutral at the specified bank angle.

During the roll, the elevator position was held constant unless changed as needed to avoid exceeding the required test load factor.

SECTION III

HYSTERESIS EFFECTS

Hysteresis effects were investigated during the 70-hour wind tunnel test to determine if any existed, at what conditions they were prevalent and how they could be avoided. Configuration 30 was chosen as the test sequence for this investigation. Data were taken at a given alpha from the negative beta limit to the positive beta limit, then back to the negative limit. This procedure was repeated for all alphas and Mach numbers. In addition, a set of alpha sweeps for zero beta was taken for each Mach number.

The analysis included inspection of data plots and the differences between the data curves. The curve differences were determined by subtraction of the two data curve Y values at a fixed X value. Plotted along with the data differences is the noise level of the data differences to show discrepancies between the two types of data taking. The noise level was calculated by taking the basic equation,

$$t = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{\sigma_{(\bar{X}_1 - \bar{X}_2)}} \tag{3}$$

with the null hypothesis $N_1 = N_2$. This means making a search for data differences above a selected level determined by t. The standard error of the difference in the two means, $\sigma_{(\bar{X}_1 - \bar{X}_2)}$, is determined from the equation:

$$\sigma_{(\bar{X}_1 - \bar{X}_2)} = \sigma\sqrt{\frac{1}{n_1} + \frac{1}{n_2}} \tag{4}$$

where n_1 and n_2 are the number of samples comprising one data point on curve 1 or curve 2 and σ is the standard deviation of the data. Since each data point on each data curve is determined by one sample:

$$\sigma_{(\bar{X}_1 - \bar{X}_2)} = \sigma\sqrt{2}$$

thus
$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sigma\sqrt{2}} \tag{5}$$

and
$$\bar{X}_1 - \bar{X}_2 = t\,\sigma\sqrt{2}$$

or
$$YDIFF = t\,\sigma\sqrt{2}$$

The noise level of the differences between the two means is then defined:

$$(\overline{X}_1 - \overline{X}_2)_{NL} = (t\ \sigma\sqrt{2})_{NL} \tag{6}$$

The t value is selectable and a value of 3.09 was chosen; this includes within the noise level 99.9% of all points that should be included within the noise level. The standard deviation, σ, is calculated by averaging σ of all data points at a given Mach number. Since the σ variation over the range of α and β is small for each coefficient and Mach number, simplifying

$$(\text{YDIFF})_{\text{NOISE}} = 3.09\sqrt{2}\ \overline{\sigma} \tag{7}$$

This equation was then used to plot the noise level (dotted lines) on the YDIFF curves (Reference 5) with a sample plot in Appendix A, Figure A-1.

By inspection of the data curves, Figures 8 through 32, some hysteresis effects can be easily seen. However, to detect smaller, more subtle effects, the YDIFF curves (Reference 6) are needed along with a criteria for determining hysteresis effects. The criteria for detecting these effects divides the exceedances above the noise limit into three levels. Level 1 requires that three or more consecutive exceedances be present, with all exceedances less than twice the noise level. The data curves, Figures 8 through 32, indicate that, in general, exceedances less than 2 times YNOISE are difficult to detect by inspection. Therefore, a level 1 hysteresis effect may be real but have little effect on data analyses. Level 2 requires that two or more consecutive exceedances be present with at least one exceedance being between two and five times the noise level. Exceedances in this range are detectable by inspection, but their effect on aerodynamic analyses is questionable. Level 3 hysteresis effects are easily detectable by inspection of the plots and have a definite effect on aerodynamic analyses. In most instances, level 3 exceedances are large enough to change the sign and slope of the coefficient curve or at least change the magnitude of the coefficient. The requirement for level 3 is that some or all of the data must lie above the five times the noise level threshold.

An additional requirement for all exceedance levels is that a pattern be established to show that the hysteresis effects are real and consistent. This means that exceedances at one Mach number for one coefficient only are not considered as hysteresis effects even if the criteria in Table 5 are met. An acceptable pattern would consist of exceedance levels at two or more coefficients such as CN, CM, CY, or CLL for a range of alphas or betas. This would indicate that a physical phenomenon is causing the exceedances since related coefficients show a consistent exceedance pattern. A summary of hysteresis effects detected by this analysis can be found in Table 6.

TABLE 5. HYSTERESIS CRITERIA

LEVEL	CONSECUTIVE EXCEEDANCES	DATA RANGE
1	3+	YNOISE → 2 YNOISE
2	2+	2 YNOISE → 5 YNOISE
3	1+	5 YNOISE →

3.1 Pylon 1

The evident hysteresis effects on pylon 1 are limited to one Mach number and one angle of attack. The betas range from small negative angles to large positive angles. The effects at the large positive angles would seem to indicate that an asymmetric flowfield may be generated with changing sideslip. With pylon 1 being on the left wing, the spanwise flow under the wing increases outboard with increasing beta, and with stores on pylons 2 and 3 the flowfield could be developing unsteadily. Figures 8 through 12 illustrate the level 2 and 3 hysteresis effects for a MK-82 GP at Mach 0.75 and zero alpha. CN and CM do not indicate which data taking method is better, but CY, CLN, and CLL overwhelmingly show the negative to positive beta sweep yields data consistent with other angles of attack. On this basis, data taken on all other configurations were taken negative to positive. No other set of test conditions indicated such an obvious choice of the best data taking method.

3.2 Pylon 3

Hysteresis effects of three AGM-65's on a triple rail launcher (TRL) on pylon 3 are similar to those on pylon 1 but are of a lesser degree. At zero alpha, CN, CM and CLL still show some effects at small negative betas while CLN shows effects at larger positive betas. These trends seem to be a carry over from pylon 1 although they are not as strong or consistent. Three stores on a TRL may be less sensitive to hysteresis effects than a single store. In addition, the flowfield effects may become less of a factor when moving inboard. Figures 13 through 17 show these effects, but overall the data from pylon 3 are quite a bit more hysteresis-free than that of pylon 1.

TABLE 6. HYSTERESIS EFFECTS

PYLON	MACH	COEFFICIENT	α	β	NO. PTS	LEVEL
1	0.75	CN	0	6-16	6	2
		CM	0	-4,-2,6-16	2,6	3,3
		CY	0	-4,-2,6-16	2,6	2,3
		CLN	0	-4,-2,6-16	2,6	3,3
		CLN	15	-4-0	3	1
		CLN	20	-8,-6	2	2
		CLL	0	-4,-2,6-16	2,6	2,3
		CLL	20	0,2	2	2
3	0.75	CN	0	-4,-2	2	2
		CM	0	-4,-2	2	2
		CLN	0	6-16	6	1
		CLL	0	-4,-2	2	2
		CM	20	12-16	3	2
		CY	15	12-16	3	1
		CY	20	12-16	3	1
		CLN	20	12-16	3	2
5	0.50	CM	15	0,2	2	2
		CLN	15	-2,0,2	3	2
	0.75	CM	0	8,10	2	2
		CLN	10	8,10,12	3	2
8	0.75	CM	0	8,10	2	3
		CY	0	8,10	2	2
		CLN	0	8,10	2	2
		CLL	0	8,10	2	2
10	0.75	CN	0	2,4	2	2
		CM	0	2,4,6	3	3
		CY	0	2,4,6	3	3
		CLN	0	2,4,6	3	3
		CLL	0	2,4,6	3	3
		CM	5	-6,-4	2	3
		CY	5	-6,-4	2	2
		CLN	5	-14-(-4)	5	2
		CLL	5	-8,-6,-4	3	2
		CM	10	-12,-10,-8	3	2

3.3 Pylon 5

The MK-82 GP exhibits a different pattern of hysteresis effects from that of pylons outboard of the wheel assembly, Figures 18 through 22. None of the detected exceedances was stronger than level 2, but were somewhat consistent with those of pylon 8 at Mach 0.75 and zero alpha. The combination of the fuselage and store on pylon 7 could be a contributing factor to these relatively light hysteresis effects.

3.4 Pylon 8

The TER rack of MK-82 GPs on pylon 8 shows a stronger pattern at Mach 0.75, zero alpha, and 8 to 10 beta, Figures 23 through 27. This trend is only hinted at on pylon 5, but the more outboard location of pylon 8 may be a factor in this exceedance strengthening. The wheel assembly adjacent to pylon 8 may be the cause of this hysteresis effect but this could not apply to pylon 5. The beta range of the hysteresis effects on both pylons may be the same but the generators of the effects may be quite different.

3.5 Pylon 10

The MK-82 GP on pylon 10 verifies the hysteresis effects found on pylons 1 and 3, Figures 28 through 32. At zero alpha, level 3 hysteresis effects occur at small positive betas which correspond directly with the small negative beta effects of pylons 1 and 3. At 5 degrees alpha, small effects begin to show at small to moderate negative betas. These are comparable with the effects at moderate to large positive betas on pylons 1 and 3. This shows the general consistency of the hysteresis effects at the three most outboard pylons.

In summary, the hysteresis effects on the A-10 are generally minimal, that is, barely visually detectable or of questionable consequence to other aerodynamic analyses. In all level 1 or level 2 exceedance cases it is impossible to determine which method of data taking is more desirable, negative to positive beta or positive to negative beta. Alpha sweeps seem to show no consistent significant hysteresis effects. However, the level 3 exceedance cases of pylons 1 and 10 are definitely visually detectable and can be potentially misleading with any aerodynamic analysis. Even with these large exceedances, only C_Y, CLN, and CLL of pylon 1 at Mach 0.75 and zero alpha give an indication of the preferred data taking method. These three cases indicate the preferred method is negative to positive beta. Based on these three cases, all data taken during the rest of the test were taken negative to positive with the assumption that this method yields the best data. As a result, all data comparisons in the remainder of this report are assumed free of all relative hysteresis effects.

SECTION IV

ADJACENT STORE EFFECTS

The aerodynamic effects of captive stores upon one another when in proximity to adjacent pylons is an important consideration in determining economic wind tunnel testing procedures and total interference airloads on stores. Time and money spent on captive airloads wind tunnel tests can be reduced if configurations that utilize the optimum number of pylons are tested. A store may have an appreciable effect on neighboring stores. However, the absence of significant effects would allow increased test productivity since proximate stores could be tested without altering their individual aerodynamic coefficients. Parameters such as size, shape, and number of stores contribute to the total interference effect between store configurations on adjacent pylons. Determining the individual contributions of these parameters lends insight into the principal causes of various adjacent pylon effects. The objective of this section, then, is to investigate both the total adjacent pylon effects for determining optimum wind tunnel testing procedures and the contributions of individual parameters.

The first task, determining total adjacent pylon effects, is approached in a manner similar to that of the hysteresis effects study, Equations (3) through (7). The theory for determining hysteresis effects from differences between data curves is used here for adjacent pylon effects. An exceedance criteria is established based upon the data noise level and the trend of the data points. The data points need not exhibit consecutive exceedances, as in the hysteresis criteria, but must indicate an exceedance trend for a series of α, β, or Mach numbers. Table 7 summarizes the exceedance criteria.

TABLE 7. ADJACENT PYLON EFFECTS EXCEEDANCE CRITERIA

LEVEL	EXCEEDANCE TRENDS	DATA RANGE
1		YNOISE → 2 YNOISE
2	α, β, Mach	2 YNOISE → 5 YNOISE
3		5 YNOISE →

A level 1 exceedance generally indicates that effects are small and probably will not affect normal aerodynamic analyses. Level 2 exceedances indicate intermediate effects that would have a definite effect upon most aerodynamic analyses. Level 3 exceedances indicate large effects that cannot be ignored in any analysis.

Next, the matrix of comparisons was generated based on wing locations. All pylons outboard of the landing gear fairings (1, 2, 3, 9, 10, 11) are considered as one class while all pylons inboard of the fairings (4, 5, 6, 7, 8) are compared as another class. Comparisons between an outboard and an inboard pylon are considered to be in the class of the main pylon as opposed to the adjacent pylon. Outboard pylons 2, 9, 11 are nonmetric, consequently these cannot be considered as main pylons. However, metric pylons 1, 3, 10 are mirror images providing opposite wing comparisons. Similarly inboard pylons 4, 7 are nonmetric but can be compared to metric pylons 5, 8. Table 9 lists the cases studied in this analysis.

Another area of consideration is the store size and carriage arrangement on both the main and adjacent pylons. Stores were classified as large and small and carried single carriage or were on TER, TRL, or MSER racks. How the stores are carried is self-explanatory but the store size is not quite so obvious. Merely taking store diameter as a large/small criteria does not take into account the large variation in store lengths. In order to take this into account, the criteria for large versus small stores were based on a product of the store length and diameter. When tabulating this parameter for all the stores, a natural division line occurred making selection of large and small stores a simple task. Table 8 lists the stores by category.

TABLE 8 . STORE DESIGNATIONS

SMALL STORES	LARGE STORES
MK-82 GP	BLU-1 (U)
MK-82 SE	GBU-8
MK-20	GBU-10
SUU-30	GBU-15 CWW
GBU-12	GBU-15 PWW
AGM-65	600 Gallon Tank

In conducting the analysis, store data from the pylon designated the main pylon (that pylon on which effects from adjacent pylons act) with no adjacent stores present is compared, using the theory, to main pylon store data with adjacent stores present. The results are then plotted against the noise level to determine the exceedance level of the data differences. The exceedance data plots used in the analysis are in ref. 6 with a sample plot in the Appendix.

Tables 10 through 14 summarize the exceedance levels for the normal and side force coefficients at all test conditions. Only the force coefficients are presented in the tables. It is characteristic of the data that the moment coefficient exceedances are always significant if the force coefficient exceedances are significant. Where the force coefficient exceedances are not

TABLE 9. ADJACENT PYLON CASES

CASE	CONFIGS COMPARED	MAIN PYLON	MAIN STORE	ADJACENT PYLON	ADJACENT STORE
1	5	1	MK-82 G	-	-
2	20		SUU-30	-	-
3	23		MK-20	-	-
4	18		GBU-12	-	-
5	5, 6		MK-82 G	2	MK-82 G
6	5, 22		MK-82 G		SUU-30
7	20, 19		SUU-30		MK-82 G
8	20, 21		SUU-30		SUU-30
9	23, 24		MK-20		MK-20
10	23, 25		MK-20		SUU-30
11	18, 17		GBU-12		LAU-68
12	18, 36		GBU-12	3	MK-82 G
13	5, 15		MK-82 G		SUU-30 TER
14	5, 28		MK-82 G		GBU-10
15	5, 35		MK-82 G		MK-82 G
16	16	3	MK-82 G	-	-
17	27		GBU-10	-	-
18	9		GBU-15 CWW	-	-
19	33		GBU-15 PWW	-	-
20	13		SUU-30 TER	-	-
21	32		AGM-65 TRL	-	-
22	16, 35		MK-82 G	1	MK-82 G
23	16, 36		MK-82 G		GBU-12
24	27, 28		GBU-10		MK-82 G
25	13, 15		SUU-30 TER		MK-82 G
26	16, 7		MK-82 G	2	MK-82 G
27	9, 10		GBU-15 CWW		MK-82 G
28	13, 12		SUU-30 TER		MK-82 G
29	33, 34		GBU-15 PWW		SUU-30
30	9, 8		GBU-15 CWW	4	MK-82 G T
31	13, 11		SUU-30 TER		MK-20 MSER
32	13, 14		SUU-30 TER		MK-20 TER
33	27, 26		GBU-10		GBU-10
34	32, 29		AGM-65 TRL		GBU-10
35	6	5	SUU-30	-	-
36	24		GBU-10	-	-
37	19		MK-82 S T	-	-
38	22		MK-82 G M	-	-

TABLE 9. ADJACENT PYLON CASES (CONCLUDED)

CASE	CONFIGS COMPARED	MAIN		ADJACENT	
		PYLON	STORE	PYLON	STORE
39	6, 5	5	SUU-30	4	SUU-30
40	19, 18		MK-82 S T		MK-82 S T
41	22, 20		MK-82 G M		MK-82 S M
42	24, 23		GBU-10		GBU-10
43	6, 7		SUU-30	7	SUU-30
44	19, 17		MK-82 S T		MK-82 S T
45	22, 21		MK-82 G M		MK-82 S M
46	24, 25		GBU-10		GBU-10
47	35	8	GBU-12	-	-
48	33		GBU-8	-	-
49	27		GBU-10	-	-
50	15		MK-20 TER	-	-
51	9		MK-20 MSER	-	-
52	9, 11		MK-20 MSER	4	MK-20 MSER
53	15, 14		MK-20 TER		MK-20 TER
54	9, 10		MK-20 MSER	7	MK-20 MSER
55	15, 16		MK-20 TER		MK-82 S T
56	27, 26		GBU-10		GBU-10
57	35, 36		GBU-12		GBU-12
58	9, 12		MK-20 MSER	9	SUU-30 TER
59	15, 13		MK-20 TER		SUU-30 TER
60	27, 28		GBU-10		GBU-10
61	27, 29		GBU-10		AGM-65 TRL
62	33, 34		GBU-8		GBU-8
63	7	10	SUU-30	-	-
64	19		BLU-1 (U)	-	-
65	20		MK-82 G	-	-
66	7, 4		SUU-30	8	BLU-1 (U)
67	7, 9		SUU-30		MK-20 MSER
68	7, 15		SUU-30		MK-20 TER
69	7, 5		SUU-30	9	SUU-30
70	7, 8		SUU-30		SUU-30 TER
71	19, 18		BLU-1 (U)		GBU-15 CWW
72	20, 23		MK-82 G		MK-82 G T
73	20, 24		MK-82 G		AGM-65 TRL
74	20, 25		MK-82 G		SUU-30 TER
75	7, 6		SUU-30	11	SUU-30
76	20, 21		MK-82 G		MK-82 G

Note: Dashes indicate no adjacent pylon or store comparisons were made

significant, only then would the moment coefficient exceedances be considered. The moment coefficients are presented in Reference 6. The exceedance level listed is the highest encountered for any angle of sideslip. The positive or negative signs indicate the β at which the largest exceedances occur. A summary plot of data differences versus the main pylon data for all coefficients is presented for each case comparison for the purpose of indicating the magnitude of the data as well as the adjacent pylon effect. These plots give an overall indication of the effects one store has on an adjacent store and allows making a judgment of the effects the data may have on one particular analysis. The percent curves indicate the line of data difference to data magnitude ratio. These are important when considering the amount of data and what coefficients lie above an acceptable limit. For example, if a data difference of 25% is acceptable for a given analysis, then all the data below the 25% curve meet this criterion. If, in addition, all data magnitudes below 0.2, regardless of percent difference, are acceptable, these two conditions would determine whether adjacent store effects need to be taken into account in that particular analysis. This would be important in planning future wind tunnel tests to obtain the most economical test plan. Figure A-2 is a sample plot.

4.1 Outboard Pylons

4.1.1 Pylon 1 (Pylon 11)

Pylon 1 can only support single-carriage small stores. The MK-82 GP, GBU-12, SUU-30 and MK-20 were tested on main pylon 1 with various stores on adjacent pylons 2 and 3. It is assumed that stores on other pylons do not affect those on pylon 1. Table 10, (a) and (b) summarizes the exceedance levels for the normal and side force coefficients at all test conditions.

By inspection, stores on pylon 1 are affected most significantly by stores on pylon 2, which is expected. Except for the zero alpha conditions, all cases generally experience level 1 or 2 exceedances. In the majority of cases, adjacent store effects on pylon 1 occur at positive angles of sideslip, with beta generally greater than 10 degrees. This is consistent physically because a positive β (aircraft nose left) results in an increased outflow under the wing toward pylon 1. The zero alpha conditions exhibit quite a dramatic change. Nearly all cases of zero alpha and Mach 0.65 or 0.75 show a level 3 exceedance. This strange action of the data, Figures 33 through 44, was similarly seen in the hysteresis study. In the hysteresis study, the store configuration remained constant while the data taking method changed. Here, the data taking method is fixed, negative to positive beta, while the store configuration changes. Although the resulting quirk in the data is presumed to arise in both instances from a very nonlinear varying flowfield with changing α or β, the causes of the flowfield may be quite different. The data taking method is seen to be the cause in the hysteresis study, while the store configuration is identified here. It should be noted that in the hysteresis study, the data taken on pylon 1 (MK-82 GP) from negative to positive beta were very smooth with a MK-82 GP on pylon 2. Similarly, case 5 indicates fairly smooth data with a MK-82 GP on pylon 1 and on pylon 2, Figures 33 and 34. Thus, both in the hysteresis and adjacent pylon study, a single store on pylon 2 tended to linearize the flowfield around pylon 1, eliminating the strange data jump. Cases 6 and 11 continue to uphold this contention. Both cases have MK-82 size stores on pylon 1 with a store adjacent on pylon 2. Both cases show fairly smooth data, Figures 33, 34, 39 and 40. However, in cases 7 through 10 beginnings of the data jump

TABLE 10. PYLON 1 EXCEEDANCE LEVELS

(a) CN

CASE	MAIN		ADJACENT		MACH											
					0.30			0.50			0.65			0.75		
	PYLON	STORE	PYLON	STORE	α_0	α_{10}	α_{20}	α_0	α_{10}	α_{20}	α_0	α_{10}	α_{20}	α_0	α_{10}	α_{20}
5	1	MK-82G	2	MK-82G			1+	1+		1+	3+		2+	3+	1+	2+
6	1	MK-82G	2	SUU-30	1+	2+	2+	2+	2+	2+	3+	2+	2+	3+	3+	3+
7	1	SUU-30	2	MK-82G							2+			3±		
8	1	SUU-30	2	SUU-30		1+	1+	2+	1+	1+	2+	1+	1+	3±	2+	2+
9	1	MK-20	2	MK-20	1-			2+	1+	1+	2+	1+	1+	3±	1+	1+
10	1	MK-20	2	SUU-30	2-			2+		1+	3+	1+	1+	3±	1+	1+
11	1	GBU-12	2	LAU-63			1+	1-		1+	3+		1-	3+	1+	1+
12	1	GBU-12	3	MK-82G							1+			2+		
13	1	MK-82G	3	SUU-30TER						1±	2+	1±	1-	3+	1±	1±
14	1	MK-82G	3	GBU-10	1+							1∓		2±		
15	1	MK-82G	3	MK-82G		1+	2+	1+		2+		1+	2+	2+		2+

(b) CY

CASE	MAIN		ADJACENT		MACH											
					0.30			0.50			0.65			0.75		
	PYLON	STORE	PYLON	STORE	α_0	α_{10}	α_{20}	α_0	α_{10}	α_{20}	α_0	α_{10}	α_{20}	α_0	α_{10}	α_{20}
5	1	MK-82G	2	MK-82G			1+	1+	1+	1+	3+	2+	2+	3+	2+	2+
6	1	MK-82G	2	SUU-30	1+	1+	2+	1+	2+	2+	3+	2+	2+	3+	2+	2+
7	1	SUU-30	2	MK-82G							1+	1+	1+	3+	1+	
8	1	SUU-30	2	SUU-30		1-	1+	2-	1+	1+	2+	2+	2+	3+	2+	2+
9	1	MK-20	2	MK-20		1+	1+	2-	1+	1±	3∓	1+	2+	3∓	1+	2+
10	1	MK-20	2	SUU-30			1+	2-	1+	1∓	3+	2+	2+	3∓	2+	2+
11	1	GBU-12	2	LAU-68			1+	1-	1∓	1+	3+	1+	2+	3∓	2+	2+
12	1	GBU-12	3	MK-82G				2+		1+	2+	1+		2+	1+	
13	1	MK-82G	3	SUU-30TER		1+	1+		1+	2+	3+	2+	2+	3+	2+	2+
14	1	MK-82G	3	GBU-10	1+	1+			1+	1+	1+	2+	2+	3+	2+	2+
15	1	MK-82G	3	MK-82G						1+	3+		1+	3±		2+

Note: Blanks denote less than level 1 exceedance

phenomena are present, Figures 35 through 38. Since the SUU-30 and MK-20 in cases 7 through 10 are a larger diameter than the MK-82, the conclusion may be drawn that the larger the store on pylon 1, the more it is affected by a store on pylon 2.

With a store or stores on pylon 3 and with pylon 2 empty, the evidence of this data jump surfaces again, cases 12 through 15, Figures 41 through 44. The larger the store(s) on pylon 3, the more pronounced the effects, with the TER of SUU-30's showing the greatest data jump. Thus, the larger the store configuration on pylon 3 the more severe the data jump evident on pylon 1. However, small stores on pylon 3 have some smoothing effect since the data jump for cases 12 through 15 is generally less than for cases 1 through 4 in which pylons 2 and 3 are empty. Note that the landing gear fairing may have some effect on the pylon 1 flowfield, especially with pylons 2 and 3 empty. In conclusion, it can be said that stores on pylon 1 are affected by store configurations on pylons 2 and 3, especially at zero alpha, so as not to allow independent testing of stores on pylon 1 without regard to any stores on pylons 2 and 3. Some limited test conditions exist that would allow concurrent testing, e.g., α = 0 through 10; Mach = 0.30, 0.50; stores on pylons 1 and 3 with pylon 2 empty. However, these conditions are so limited that they are the exception rather than the rule, and would not be practical in an overall test of a store to be cleared for flight on pylon 1.

Secondly, the larger the diameter of the store on pylon 1, the more it is affected by store configurations on pylons 2 and 3. However, this effect on pylon 1 is dependent upon the diameter fo the store configuration on pylons 2 or 3.

4.1.2 Pylon 10 (Pylon 2)

Pylon 10 can only support single-carriage small stores with one exception, the BLU-1, designated as a large store. The MK-82 GP and SUU-30 were tested as small stores on pylon 10. Adjacent pylons considered in the analysis were pylons 8, 9, and 11. It is assumed that stores on all other pylons have no effect on pylon 10 stores. Table 11, (a) and (b) summarizes the exceedance levels for the normal and side force coefficients at all test conditions.

By evidence of cases 66 through 68 and Figures 45 and 46, stores on pylon 8 have little or no impact upon stores on pylon 10. This is not surprising since the two pylons are separated by the right landing gear fairing. This fairing is large enough to greatly reduce the outflow under the wing from pylon 8 to pylon 10. However, the fairing itself could play an important role in changing the flowfield aroung pylon 10, especially at negative β's. The data jump phenomenon exhibited on pylon 1 at zero alpha shows up very sparingly here. Only Mach numbers 0.65 and 0.75 are affected and then only at relatively few β's, generally between 0 degree β and -5 degrees β.

However, inspection of the coefficients, CLN and CLL, Reference 6, indicates a larger band of negative β's that show pylon 10 stores are influenced by pylon 8 stores or by the landing gear fairing. Consequently, for testing purposes, it would be erroneous to assume pylon 8 stores have no effect on pylon 10 stores.

TABLE 11. PYLON 10 EXCEEDANCE LEVELS

(a) CN

CASE	MAIN		ADJACENT		MACH 0.30			MACH 0.50			MACH 0.65			MACH 0.75		
	PYLON	STORE	PYLON	STORE	α_0	α_{10}	α_{20}	α_0	α_{10}	α_{20}	α_0	α_{10}	α_{20}	α_0	α_{10}	α_{20}
66	10	SUU-30	8	BLU-1(U)										2-		
67	10	SUU-30	8	MK-20MSER								1-		2-	1-	1-
68	10	SUU-30	8	MK-20TER		1-			1-		2-		1-	2-	1-	1-
69	10	SUU-30	9	SUU-30	1+	2-	2-	1+	2-	2-	2+	2-	2-	2±	2-	2-
70	10	SUU-30	9	SUU-30TER		3-	2-		3-	3-	3-	3-	3-	3-	3-	3-
71	10	BLU-1(U)	9	GBU-15CWW	1-	2-	2-	2+	2-	3-	2+	3-	3-	3+	3-	3-
72	10	MK-82G	9	MK-82GT	2±	2-	3-	3-	3-	3-	3-	3-	3-	3-	3-	3-
73	10	MK-82G	9	AGM-65TRL	2±	3-	3-	1±	3-	3-	2±	3-	3-	2+	3-	3-
74	10	MK-82G	9	SUU-30TER	2±		3-	3-	3-	3-	3-	3-	3-	3-	3-	3-
75	10	SUU-30	11	SUU-30	1+	1+	1+	2+	1+	1+	2+	1+	1+	2+	2+	2+
76	10	MK-82G	11	MK-82G	1±	1+		1+	1+		2±	2+	2-	2+	2+	2-

(b) CY

CASE	MAIN		ADJACENT		MACH 0.30			MACH 0.50			MACH 0.65			MACH 0.75		
	PYLON	STORE	PYLON	STORE	α_0	α_{10}	α_{20}	α_0	α_{10}	α_{20}	α_0	α_{10}	α_{20}	α_0	α_{10}	α_{20}
66	10	SUU-30	8	BLU-1(U)										3-		
67	10	SUU-30	8	MK-20MSER							1-			3-		1-
68	10	SUU-30	8	MK-20TER												
69	10	SUU-30	9	SUU-30		1-	1-	2+	1-	2-	1+	2-	2-	2+	2-	2-
70	10	SUU-30	9	SUU-30TER	1-	3-	3-	1±	3-	3-	3-	3-	3-	3-	3-	3-
71	10	BLU-1(U)	9	GBU-15CWW	2-	2-	3-	2-	2-	3-	3-	3-	3-	3-	3-	3-
72	10	MK-82G	9	MK-82GT	1±	2-	2-	2-	2-	2-	3-	3-	3-	3-	3-	3-
73	10	MK-82G	9	AGM-65TRL	2-	3-	3-	2-	3-	3-	3-	3-	3-	3-	3-	3-
74	10	MK-82G	9	SUU-30TER	2-		2-	2±	3-	3-	3-	3-	3-	3-	3-	3-
75	10	SUU-30	11	SUU-30		1-	1-	1+	2-	2-	2+	2-	2-	2+	2±	2+
76	10	MK-82G	11	MK-82G		1-	1-		1-	1-	2±	1±	2-	2±	2-	2-

Note: Blanks denote less than level 1 exceedance

All store configurations tested on pylon 9 have significant effects upon any store tested on pylon 10, cases 69 through 74 and Figures 47 through 52. Nearly all test conditions show the greatest effects when β is negative. This is physically correct, since negative β is nose right, which would increase the outflow under the right wing toward pylon 10. The effects are significant enough to completely overshadow any data jump phenomenon present. All multiple-carriage and single large stores on pylon 9 show level 3 exceedances at nearly all test conditions. The only single-carriage small store, case 69, indicates a lesser effect with a maximum of level 2. This continues to follow the trend set by pylon 1; that is, the larger the store configuration on pylon 9 the larger the effect on the store on pylon 10. The least influential store on pylon 9 is the SUU-30 with the greatest influence being the AGM-65 Triple Rail Launcher. It should be noted that case 69 compares to case 8 in that the exceedance levels are generally the same and the pylon spacing is similar. Although this result may be trivial, it lends consistency to the results.

Pylon 11, like pylon 1, can carry only small single-carriage stores. Only a SUU-30 and an MK-82 GP were tested on pylon 10 with like stores on pylon 11, cases 75, 76, Figures 53 through 56. Both cases indicate a level 2 exceedance for most test conditions with the MK-82 GP having slightly fewer level 2 exceedances. This is consistent with previous conclusions; since the MK-82 GP has a smaller diameter than the SUU-30, it should be less affected. Many exceedances occur at positive β's, which is expected. However, a significant number occur at negative β's. This can be explained physically. The chordwise location of stores carried on pylon 11 is actually forward of those on pylon 10. Thus, when the aircraft is at negative β, the flow off the store on the more forward pylon 11 could influence the store on pylon 10. In addition, the flow off the landing gear fairing could definitely interfere with stores on pylon 10 if pylons 9 and 11 are empty, cases 63 through 65.

The conclusion: stores tested on pylon 10 are affected by stores on pylons 8, 9, and 11. Thus, independent testing of a store on pylon 10 is possible only if pylons 8, 9, and 11 are empty. Again, the larger the adjacent store, the greater the effect on a pylon 10 store.

4.1.3 Pylon 3 (Pylon 9)

The last pylon considered as an outboard pylon is located just outboard of the landing gear fairing. This pylon is able to carry large or small single-carriage stores and triple ejector rack or triple rail launcher mounted multiple-carriage stores. As evident from Figures 57 through 62 and Table 12, (a) and (b) stores on pylon 1 have, in general, little effect on pylon 3 stores, cases 22 through 25. The zero alpha data jump phenomenon is the prevalent effect ranging from level 1 to level 3. This occurs most severely when a small store is located on pylon 3 with a store on pylon 1, but only at one positive α. As the size of the store configuration on pylon 3 increases, the observed data jump effect on pylon 3 decreases. Obviously, the flowfield off the pylon 1 store is unable to significantly affect the larger stores on pylon 3. However, the data jump effects could be due to an asymmetrical flow shedding off the landing gear fairing. It is difficult to determine which is the primary cause of the data jump; however, the proximity of the fairing to pylon 3 and the distance between pylons 1 and 3 lends validity to the belief that the fairing is the primary cause. Additional proof lies in the fact that the level 3 exceedances at zero α occur mainly at positive β (nose left). The dominant

TABLE 12. PYLON 3 EXCEEDANCE LEVELS

(a) CN

CASE	MAIN		ADJACENT		MACH											
					0.30			0.50			0.65			0.75		
	PYLON	STORE	PYLON	STORE	α_0	α_{10}	α_{20}	α_0	α_{10}	α_{20}	α_0	α_{10}	α_{20}	α_0	α_{10}	α_{20}
22	3	MK-82G	1	MK-82G	1-		1+	2+							1+	1+
23	3	MK-82G	1	GBU -12	1-			1±						2+		
24	3	GBU-10	1	MK-82G												
25	3	SUU-30TER	1	MK-82G	1-									1-		
26	3	MK-82G	2	MK-82G		1-		3+	1-		1+			2+	1-	
27	3	GBU-15CWW	2	MK-82G				2-	1-	1-	2±	1-	1-	2-	2-	1±
28	3	SUU-30TER	2	MK-82G	1±						1-			1-		
29	3	GBU-15PWW	2	SUU-30		1-	1±	2+	2-	2-	3±	2-	2-	3±	2-	
30	3	GBU-15CWW	4	MK-82GT				1+		1+	2+	1+	1+	3+	1+	2+
31	3	SUU-30TER	4	MK-20MSER	1-			1+			1-			1-		
32	3	SUU-30TER	4	MK-20TER	1-			1+			1-			1-		
33	3	GBU-10	4	GBU-10	1+		1+	2+			1-	1+	1+	1-	2+	2+
34	3	AGM-65TRL	4	GBU-10										2-		

(b) CY

CASE	MAIN		ADJACENT		MACH											
					0.30			0.50			0.65			0.75		
	PYLON	STORE	PYLON	STORE	α_0	α_{10}	α_{20}	α_0	α_{10}	α_{20}	α_0	α_{10}	α_{20}	α_0	α_{10}	α_{20}
22	3	MK-82G	1	MK-82G				3+			3+		1+	1±		1+
23	3	MK-82G	1	GBU-12				3+		1+	1±			3+	1-	1-
24	3	GBU-10	1	MK-82G				1+			1-			1-		
25	3	SUU-30TER	1	MK-82G	1±	1+					1-			1-		
26	3	MK-82G	2	MK-82G		1+	1+	3+	1+	1+	3+	1+	1+	3+	1+	2+
27	3	GBU-15CWW	2	MK-82G		1+		2-	1±	1±	3+	1±	2-	3+	2-	2±
28	3	SUU-30TER	2	MK-82G	1±	1+		1-			1-			1-		
29	3	GBU-15PWW	2	SUU-30	1-	1-	1±	2-	2-	2-	2+	1±	2-	2+	2-	2±
30	3	GBU-15CWW	4	MK-82GT	1+	1+	1+	2+	2+	2+	3+	2+	2+	3+	3+	3+
31	3	SUU-30TER	4	MK-20MSER	1±	1±		1+			1±		1+	2+	1+	1+
32	3	SUU-30TER	4	MK-20TER	1±	1+		1+		1+	1±		1+	2+	1+	2+
33	3	GBU-10	4	GBU- 10		1+	1+	2+	1±	1±	2+	2+	2+	2+	2+	2+
34	3	AGM-65TRL	4	GBU-10				1+			2+	1+		1±	2+	1+

Note: Blanks denote less than level 1 exceedance

flow over pylon 3 would be from the fairing outbound, rather than the deflected flow from pylon 1. Nevertheless, pylon 1 stores must be considered since the carriage position fuselage station is nearly identical to pylon 3 and level 1 exceedances occur at negative β's. In any case, a small, single-carriage store cannot be tested on pylon 3 independent of pylon 1 stores. However, with some reservations, a large store or a rack of stores may be tested regardless of pylon 1; level 1 exceedances should be expected. Since a store on pylon 1 cannot be tested independent of pylon 3, it would serve no useful purpose to mount a store on pylon 1 unless pylon 1 and 3 interference effects are required on pylon 1.

Stores on pylon 2 have more of an effect on pylon 3 stores than do pylon 1 stores. This should be obvious since pylon 2 is closer to pylon 3. The data uphold this claim, cases 26 through 29, Figures 63 through 70. More level 2 exceedances are evident with again the largest exceedances at zero α. The exceedance pattern indicates that the larger the store on pylon 3 the smaller the effect a pylon 2 store has on pylon 3. However, as the diameter of the pylon 2 store increases, so does the effect it has on pylon 3 stores. Cases 26, 27, and 29 indicate that a single-carriage store on pylon 3 cannot be tested independent of pylon 2 stores. However, case 28 shows that a multiple-carriage configuration on pylon 3 with a small diameter store on pylon 2 can be tested with no adverse effects. This arrangement may not be practical since pylon 2 is nonmetric. The primary causes of the exceedances are again split between the landing gear fairing and the pylon 2 stores. Most of the smaller exceedances, levels 1 and 2, occur at negative β's, implicating the fairing as the principal influence on pylon 3. The data jump phenomenon occurs at positive β's leading to the conclusion that the large exceedances are caused by flow asymmetries off the fairing.

Pylon 4 has the capability of carrying all types of stores and racks of stores. Located on the left wing just inboard of the landing gear fairing, its effect on store outboard is uncertain. The exceedance levels in Table 12, (a) and (b) indicate a definite effect on pylon 3 stores. However, whether the store(s) on pylon 4 or the flow off the landing gear fairing is the cause of the exceedances is the question. Since most exceedances occurred at positive β's (nose left) the data are consistent with the physical situation. A small number of low level exceedances occur at negative β's (nose right) leading to the conclusion that the empty pylon 2 may have some small effect on pylon 3 stores. The trends established previously apply here also; the exceedance levels generally increase with Mach number and high exceedance levels at zero alpha are prevalent. The data at zero alpha, Figures 71 through 78, are smoother than data seen previously on other pylons; however, the exceedance levels are comparable. The large single-carriage stores are most readily affected, but both are affected similarly. The rack carriage stores are somewhat less affected, but all are affected similarly even though the stores on pylon 4 vary significantly. Since the size variation of stores on pylon 4 does not seem to affect a given class of stores (large or multiple carriage) on pylon 3, it is possible that, although pylon 4 stores are influential, their particular influence is smoothed out by the landing gear fairing resulting in a relatively constant influence across the fairing. The effects are significant enough to conclude that independent testing should not be done with stores on pylons 3 and 4.

4.2 Inboard Pylons

4.2.1 Pylon 8 (Pylon 4)

Pylon 8 has the capability of carrying any type loading. It is located just inboard of the landing gear fairing. MK-20 TER and MSER loads along with GBU-8, GBU-10, and GBU-12 stores were tested on pylon 8 with adjacent store loads on pylons 4, 7, and 9. Stores on pylons 1, 2, 3, 10, and 11 were assumed to have no effect on pylon 8 stores. Table 13, (a) and (b) summarizes the exceedance levels for the normal and side forces at all conditions.

By inspection of Figures 79 through 82, stores on pylon 8 are not appreciably affected by pylon 4 stores. However, plots in Reference 6 indicate level 1 and 2 exceedances for the moments CM, CLN, CLL. This may or may not be significant for various analyses, but should be considered when testing on pylons 4 and 8 concurrently. These moment exceedances occur mainly at positive betas but also at negative betas. This indicates that the right landing gear fairing has a more dominating effect on pylon 8 stores than do pylon 4 stores. As a result, it is judged that stores can be tested concurrently on pylons 4 and 8 so long as caution is observed in applying the moment data to any analysis. In addition, because no large or small single-carriage stores were tested on pylon 8, the effects of pylon 4 stores upon these types of stores is unknown. It is estimated that like stores on pylons 4 and 8 would yield differences no greater than those seen in the cases presented here. However, effects of large pylon 4 stores on small pylon 8 stores remains an unanswered question.

Stores on pylon 7 have a dramatic effect on pylon 8 stores as seen in Figures 83 through 90 and cases 54 through 57 in Table 13, (a) and (b). From the four cases presented it is evident that the longer configuration, i.e., MSER rack, GBU-10, GBU-12, show the largest effects. The predominant exceedance beta angle is negative, which supports the contention that the pylon 7 stores are the dominant influence on pylon 8 stores. A small amount of exceedances occur at positive beta indicating an effect from the right landing gear fairing. In conclusion, stores cannot be tested concurrently on pylons 7 and 8 to obtain independent airloads.

Stores on pylon 9 have a lesser effect on pylon 8 stores than do pylon 7; only level 1 and 2 exceedances occur. In fact, cases 58 and 59 indicate minimal effects, Figures 91 through 94. However, inspection of plots in Reference 6 indicates large exceedances from the moment coefficient. This would eliminate any thought of independent testing on pylons 8 and 9. Cases 60 through 62 show significant effects for CY at higher Mach numbers, Figures 95 through 98. The majority of the exceedances occurs at positive betas indicating influence from the pylon 9 store. However, the landing gear fairing, as in the pylons 3 and 4 case, may be contributing to the exceedance level leaving the extent of each contribution uncertain. Note that length and size of the store configuration on the adjacent pylon yields generally larger exceedances. It must be assumed that pylon 9 stores have some effect on pylon 8 stores and refrain from independent concurrent testing.

In summary, independent concurrent testing of stores on pylon 8 with adjacent pylons 7 and 9 is inadvisable. Testing may be attempted with stores on pylon 4, but with caution. Since pylon 4 stores present a borderline

TABLE 13. PYLON 8 EXCEEDANCE LEVELS

(a) CN

CASE	MAIN PYLON	MAIN STORE	ADJACENT PYLON	ADJACENT STORE	MACH 0.30 α_0	0.30 α_{10}	0.30 α_{20}	0.50 α_0	0.50 α_{10}	0.50 α_{20}	0.65 α_0	0.65 α_{10}	0.65 α_{20}	0.75 α_0	0.75 α_{10}	0.75 α_{20}
52	8	MK-20MSER	4	MK-20MSER												
53	8	MK-20TER	4	MK-20TER										2-		
54	8	MK-20MSER	7	MK-20MSER	2-	2-	2-	2±	2-	3-	3±	3-	3-	3+	3-	3-
55	8	MK-82ST	7	MK-82ST				1+						3-	1+	
56	8	GBU-10	7	GBU-10	2-	2-	2-	2-	3-	3-	2±	2-	3-	2-	3-	3-
57	8	GBU-12	7	GBU-12	1±	3-	2-	2+	2-	3-	2±	2-	3-	3+	2-	3-
58	8	MK-20MSER	9	SUU-30TER				1-			2-			2-	1±	
59	8	MK-20TER	9	SUU-30TER							2-			1-		
60	8	GBU-10	9	GBU-10											1+	
61	8	GBU-10	9	AGM-65TRL						1+	2+	1+	1+		1±	1±
62	8	GBU-8	9	GBU-8				1+			2+		2-	2+	1+	

(b) CY

CASE	MAIN PYLON	MAIN STORE	ADJACENT PYLON	ADJACENT STORE	MACH 0.30 α_0	0.30 α_{10}	0.30 α_{20}	0.50 α_0	0.50 α_{10}	0.50 α_{20}	0.65 α_0	0.65 α_{10}	0.65 α_{20}	0.75 α_0	0.75 α_{10}	0.75 α_{20}
52	8	MK-20MSER	4	MK-20MSER												
53	8	MK-20TER	4	MK-20TER										2-		
54	8	MK-20MSER	7	MK-20MSER	2+	2±	3-	3+	3+	3-	3-	3-	3-	3±	3-	3-
55	8	MK-20TER	7	MK-82ST				1-	1-	1-	2+			3-	1±	2-
56	8	GBU-10	7	GBU-10	2-	2-	2-	3-	3-	2-	3-	3-	3-	3-	3-	3-
57	8	GBU-12	7	GBU-12	1±	2-	1+	2±	2±	2-	3-	3-	3-	3-	3-	3-
58	8	MK-20MSER	9	SUU-30TER				1+			1±	1+		2+	1+	
59	8	MK-20TER	9	SUU-30TER	1-	1-					1-	1-		2-	1+	
60	8	GBU-10	9	GBU-10				1-	1-	1-	2+	1±	2+	1+	1±	1±
61	8	GBU-10	9	AGM-65TRL	1±	1±	1±	1±	1±	2-	2+	2±	2±	2+	2±	2±
62	8	GBU-8	9	GBU-8	1+	1±	1±	1±	2-	2±	2±	2±	2+	3-	2±	2+

Note: Blanks denote less than level 1 exceedance

case, it is judged that pylons 5 and 6 would be unacceptable concurrent testing pylons. Future testing could address pylons 5, 8 testing as well as pylons 4, 8 testing with single carriage stores.

4.2.2 Pylon 5 (Pylon 7)

Pylon 5 is significantly affected at all conditions by stores on pylons 4 and 7, Table 14, (a) and (b). All types of stores were tested on pylon 5 with similar configurations on pylons 4 and 7. Level 2 and 3 exceedances are predominant in the longer store configurations, cases 41, 42, 45, 46, while level 1 and 2 exceedances dominate the shorter store configurations, cases 39, 40, 43, 44. In cases 39 through 42, the majority of exceedances occurs at negative betas indicating the influence off the adjacent pylon 4 configuration, Figures 99 through 106. The number of positive beta exceedances indicates a possible unsteady flow condition off the empty pylon 6 or the fuselage. The majority of exceedances in cases 43 through 46, Figures 107 through 114, is at positive betas indicating the influence of the adjacent pylon 7 stores. The number of negative beta exceedances indicates an unsteady flow off the left landing gear fairing. In any event, stores on pylon 5 should not be tested concurrently with pylon 4 or 7 stores to obtain independent data.

TABLE 14. PYLON 5 EXCEEDANCE LEVELS

(a) CN

CASE	MAIN		ADJACENT		MACH											
					0.30			0.50			0.65			0.75		
	PYLON	STORE	PYLON	STORE	α_0	α_{10}	α_{20}	α_0	α_{10}	α_{20}	α_0	α_{10}	α_{20}	α_0	α_{10}	α_{20}
39	5	SUU-30	4	SUU-30		1-			1-		2±	1-	1-	3-	2-	2-
40	5	MK-82ST	4	MK-82ST		1-	1-	1±	1±	1±	2±	2-	2±	3-	2±	2±
41	5	MK-82GM	4	MK-82SM	1-	2-	2±	1-	2-	3-	2±	3-	3±	3-	3-	3±
42	5	GBU-10	4	GBU-10	1+	2-	2-	1+	[illegible]	3-	3-	2+	3-	3-	2±	3-
43	5	SUU-30	7	SUU-30		1+	1+	1-		1±		1±	1+	1±	1±	1-
44	5	MK-82ST	7	MK-82ST							2-			2-		
45	5	MK-82GM	7	MK-82SM	1-	2+	2+	2-	2+	2+	2-	2+	2+	2±	2+	3+
46	5	GBU-10	7	GBU-10	2+	2-	2+	2±	2+	3+	3±	2+	3+	3±	3+	3+

(b) CY

CASE	MAIN		ADJACENT		MACH											
					0.30			0.50			0.65			0.75		
	PYLON	STORE	PYLON	STORE	α_0	α_{10}	α_{20}	α_0	α_{10}	α_{20}	α_0	α_{10}	α_{20}	α_0	α_{10}	α_{20}
39	5	SUU-30	4	SUU-30			1-	1-	1-	1±	1+	1-	1±	1±	2-	2±
40	5	MK-82ST	4	MK-82ST	1±	1±	1±	1±	1±	1±	2±	2±	2±	2±	2-	2±
41	5	MK-82GM	4	MK-82SM	2-	2-	2-	2±	2-	3-	2±	3-	3-	2+	3-	3-
42	5	GBU-10	4	GBU-10	1-	2-	2-	2-	2-	2-	2+	2-	2±	2±	2±	2±
43	5	SUU-30	7	SUU-30		1-	1-	1+	1±	1±	2+	1±	1±	2+	2+	2±
44	5	MK-82ST	7	MK-82ST	1-	1-	1-	1±	1±	1±	2±	2-	2-	2±	2±	2±
45	5	MK-82GM	7	MK-82SM	2±	2±	2+	2±	2±	2±	3±	2±	3-	3±	3-	3-
46	5	GBU-10	7	GBU-10	2+	1-	2±	3+	3+	2±	3+	3+	3+	3+	3+	3+

Note: Blanks denote less than level 1 exceedance

SECTION V

FLIGHT TEST/WIND TUNNEL TEST COMPARISON

This section compares the data from the wind tunnel test with previously taken flight data. The objective of this analysis is not to indicate which type of data is more accurate, but merely to point out areas of agreement and disagreement. Eleven different comparisons spanning both the 80% and 100% loads demonstration flight tests, four pylons, four Mach numbers, three types of aircraft maneuvers, and five coefficients are presented. Four stores comprise the comparison, 600-gallon tank, BLU-1 (unfinned), SUU-30 and MK-82 GP.

To provide a rule by which to measure the data comparisons, a scoring system was devised based on the agreement of data trends and accuracy. Table 15 summarizes the point system. In the trend category, an Excellent (E) rating worth 5 points was assessed if nearly all the data points followed similar trends. A rating of Very Good (VG) worth 4 points was applied if only a majority of points agreed in the trends. A Good rating (G), 3 points, was applied if only half the data agreed in trends, a Fair rating (F), 2 points, if a minority of the data agreed, and a Poor rating (P), 1 point, if very few or no points at all agreed in their trends. The accuracy category relates the closeness of the two sets of data. It is based on the average difference between the two sets divided by the minimum-maximum range of the wind tunnel data. The percentage was determined by inspection of the data and therefore, a certain amount of judgment is inherent in the analysis results. This percentage determines the rating of the data given in the Table. The trend and accuracy category ratings are then averaged to obtain a final rating for the data and further analysis. Tables 16, 17 contain the detailed ratings scores.

TABLE 15. WIND TUNNEL/FLIGHT TESTS DATA RATING CRITERIA

TRENDS			ACCURACY		
RATING	POINTS	AGREEMENT	RATING	POINTS	AVERAGE DIFFERENCE
E	5	Nearly all points	E	5	0-25%
VG	4	Majority of points	VG	4	26-50%
G	3	Half of the points	G	3	51-75%
F	2	Minority of points	F	2	76-100%
P	1	Few/none of points	P	1	100%

TABLE 16. DETAILED DATA COMPARISON RATINGS, 80% TEST

PYLON	STORE	MANEUVER	MACH WTT	MACH FLT	COEF	RATINGS TREND	RATINGS ACCURACY	RATINGS AVERAGE	RATINGS RATING
6	600 g.t	SSS	.30	.38	CN	4	3	3.5	G-VG
					CM	5	4	4.5	VG-E
					CY	5	4	4.5	VG-E
					CLN	4	3	3.5	G-VG
			.65	.60	CN	4	3	3.5	G-VG
					CM	5	4	4.5	VG-E
					CY	5	5	5	E
					CLN	5	5	5	E
6	SUU-30MER	SSS	.50	.55	CN	2	2	2	F
					CM	5	5	5.0	E
					CY	5	4	4.5	VG-E
					CLN	4	4	4	VG
			.65	.60	CN	3	3	3.0	G
					CM	5	4	4.5	VG-E
					CY	5	5	5	E
					CLN	4	5	4.5	VG-E
					CLL	5	2	3.5	G-VG
			.75	.72	CN	3	2	2.5	F-G
					CM	5	3	4	VG
					CY	5	5	5	E
					CLN	4	5	4.5	VG-E

TABLE 16. DETAILED DATA COMPARISON RATINGS, 80% TEST (CONTINUED)

			MACH		RATINGS				
PYLON	STORE	MANEUVER	WTT	FLT	COEF	TREND	ACCURACY	AVERAGE	RATING
6	SUU-30MER	SPU	.30	.39	CN	4	1	2.5	F-G
					CM	4	2	3	G
					CY	3	1	2	F
					CLN	1	3	2	F
					CLL	2	1	1.5	F-P
			.50	.49	CN	4	1	2.5	F-G
					CYY	4	3	3.33	G
					CY	4	2	3	G
			.65	.64	CN	2	2	2	F
					CM	5	5	5	E
					CY	5	4	4.5	VG-E
					CLN	4	5	4.5	VG-E
					CLL	3	3	3	G
			.75	.73	CN	4	2	3	G
					CM	5	4	4.5	VG-E
					CY	5	4	4.5	VG-E
					CLN	5	5	5	E
					CLL	2	2	2	F
8	600 g.t.	SSS	.50	.42	CN	5	2	3.5	G-VG
					CM	4	3	3.5	G-VG
					CY	5	4	4.5	VG-E

TABLE 16. DETAILED DATA COMPARISON RATINGS, 80% TEST (CONTINUED)

PYLON	STORE	MANEUVER	MACH WTT	MACH FLT	RATINGS COEF	TREND	ACCURACY	AVERAGE	RATING
8	600 g.t.	SSS	.50	.42	CLN	5	3	4	VG
			.65	.62	CN	5	1	3	G
					CM	5	4	4.5	VG-E
					CY	5	5	5	E
					CLN	5	4	4.67	E
					CLL	5	4	4.5	VG-E
		SPU	.50	.49	CN	5	4	4.5	VG-E
					CM	5	5	5	E
					CY	5	5	5	E
					CLN	5	5	5	E
					CLL	5	4	4.5	VG-E
8	BLU-1	AR	.50	.50	CN	5	4	4.5	VG-E
					CM	4	4	4	VG
					CY	2	3	2.5	F-G
					CLN	5	4	4.5	VG-E
			.65	.61	CN	5	4	4.33	VG
					CM	3	3	3	G
					CY	4	3	3.5	G-VG
					CLN	5	4	4.5	VG-E
		SSS	.75	.72	CN	4	1.0	2.5	F-G
					CM	4	2	3	G

TABLE 16. DETAILED DATA COMPARISON RATINGS, 80% TEST (CONTINUED)

			MACH		RATINGS				
PYLON	STORE	MANEUVER	WTT	FLT	COEF	TREND	ACCURACY	AVERAGE	RATING
8	BLU-1	SSS	.75	.72	CY	5	3	4	VG
					CLN	5	5	5	E
		SPU	.50	.49	CN	5	1	3.0	G
					CM	5	5	5	E
			.65	.64	CN	2	2	2	F
					CM	5	5	5	E
			.75	.73	CN	4	3	3.5	G-VG
					CM	5	5	5	E
10	BLU-1	SSS	.50	.44	CN	3	2	2.5	F-G
					CM	2	2	2	F
					CY	5	5	5	E
					CLN	5	4	4.5	VG-E
		SPU	.30	.38	CN	4	3	3.5	G-VG
					CM	5	5	5	E
					CY	5	4	4.5	VG-E
					CLN	5	4	4.5	VG-E
			.50	.50	CN	4	3	3.5	G-VG
					CM	5	4	4.5	VG-E
					CY	5	5	5	E
					CLN	5	5	5	E
					CLL	5	4	4.5	VG-E

TABLE 16. DETAILED DATA COMPARISON RATINGS, 80% TEST (CONTINUED)

PYLON	STORE	MANEUVER	MACH		RATINGS				
			WTT	FLT	COEF	TREND	ACCURACY	AVERAGE	RATING
10	BLU-1	SPU	.65	.65	CM	4	3	3.5	G-VG
					CY	5	4	4.5	VG-E
					CLN	5	5	5	E
10	SUU-30	SSS	.50	.45	CN	4	3	3.5	G-VG
					CM	2	3	2.7	G
					CY	5	4	4.5	VG-E
					CLN	4	5	4.5	VG-E
			.65	.60	CN	4	4	4	VG
					CM	2	3	2.5	F-G
					CY	4	5	4.5	VG-E
					CLN	4	4	4	VG
			.75	.72	CN	4	2	3	G
					CM	2	3	2.5	F-G
					CY	4	3	3.5	G-VG
					CLN	5	5	5	E
		SPU	.30	.39	CN	4	3	3.5	G-VG
					CM	4	2	3	G
					CY	5	4	4.5	VG-E
					CLN	5	5	5	E
					CLL	4	3	3.5	G-VG
			.50	.49	CN	5	4	4.5	VG-E

TABLE 16. DETAILED DATA COMPARISON RATINGS, 80% TEST (CONTINUED)

PYLON	STORE	MANEUVER	MACH WTT	MACH FLT	COEF	RATINGS TREND	RATINGS ACCURACY	RATINGS AVERAGE	RATINGS RATING
10	SUU-30	SPU	.50	.49	CM	4	2	3	G
					CY	4	4	4	VG
					CLN	5	5	5	E
					CLL	5	5	5	E
			.65	.64	CN	5	3	4	VG
					CM	4	4	4	VG
					CLN	5	5	[illegible]	[illegible]
					CLL	2	2	[illegible]	[illegible]
			.75	.73	CN	4	2	[illegible]	G
					CM	4	4	4	VG
					CY	3	2	2.5	F-G
					CLN	5	4	4.5	VG-E
					CLL	2	2	2	F
11	MK-82G	SUU	.50	.46	CN	3	3	3	G
					CM	5	4	4.5	VG-E
					CY	5	3	4	VG
					CLN	4	4	4	VG
					CLL	2	3	2.5	F-G
			.65	.62	CN	4	4	4	VG
					CM	4	3	3.5	G-VG
					CY	5	4	4.5	VG-E

TABLE 16. DETAILED DATA COMPARISON RATINGS, 80% TEST (CONTINUED)

PYLON	STORE	MANEUVER	MACH WTT	MACH FLT	COEF	TREND	ACCURACY	AVERAGE	RATING
11	MK-82G	SSS	.65	.62	CLN	4	3	3.5	G-VG
					CLL	3	3	3	G
			.75	.70	CN	4	3	3.5	G-VG
					CM	4	3	3.5	G-VG
					CY	5	4	4.5	VG-E
					CLN	3	3	3	G
		SPU	.30	.40	CN	3	2	2.5	F-G
					CM	1	2	1.5	P-F
					CY	3	2	2.5	F-G
					CLN	4	5	4.5	VG-E
					CLL	4	3	3.5	G-VG
			.50	.50	CN	3	2	2.5	F-G
					CM	3	3	3	G
					CY	3	3	3	G
					CLN	5	5	5	E
					CLL	3	3	3	G
			.65	.60	CN	3	3	3	G
					CM	3	4	3.5	G-VG
					CY	3	3	3	G
					CLN	4	4	4	VG
					CLL	3	3	3	G

TABLE 16. DETAILED DATA COMPARISON RATINGS, 80% TEST (CONCLUDED)

			MACH		RATINGS				
PYLON	STORE	MANEUVER	WTT	FLT	COEF	TREND	ACCURACY	AVERAGE	RATING
11	MK-82GP	SPU	.75	.74	CN	3	2	2.5	F-G
					CM	2	3	2	F
					CY	3	1	2	F
					CLN	4	4	4	VG
					CLL	3	2	2.5	F-G

TABLE 17. DATA COMPARISON RATINGS, 100% TEST

			MACH		RATINGS				
PYLON	STORE	MANEUVER	WTT	FLT	COEF	TREND	ACCURACY	AVERAGE	RATING
10	SUU-30	AR	.65	.68	CN	4	2	3	G
					CM	3	2	2.5	F-G
					CY	4	3	3.5	G-VG
					CLN	5	4	4.5	VG-E
					CLL	3	3	3	G
			.75	.71	CN	3	2	2.5	F-G
					CM	3	2	2.5	F-G
					CY	3	2	2 5	F-G
					CLN	5	4	4.5	VG-E
					CLL	3	3	3	G
		SPU	.65	.65	CN	3	3	3	G
					CM	4	3	3.5	G-VG
					CY	4	4	4	VG
					CLN	4	4	4	VG
					CLL	4	4	4	VG

TABLE 17. DATA COMPARISON RATINGS, 100% TEST (CONTINUED)

			MACH			RATINGS			
PYLON	STORE	MANEUVER	WTT	FLT	COEF	TREND	ACCURACY	AVERAGE	RATING
10	SUU-30	SPU	.75	.73	CN	4	3	3.5	G-VG
					CM	2	2	2	F
					CY	2	3	2.5	F-G
					CLN	4	4	4	VG
					CLL	3	2	2.5	F-G
10	MK-82G	AR	.65	.67	CN	4	4	4	VG
					CM	3	2	2.5	F-G
					CY	4	4	4	VG
					CLN	4	3	3.5	G-VG
					CLN	2	3	2.5	F-G
			.75	.74	CN	4	3	3.5	G-VG
					CM	2	2	2	F
					CY	4	2	3	G
					CLN	3	4	3.5	G-VG
					CLL	2	3	2.5	F-G
		SPU	.65	.66	CN	3	2	2.5	F-G
					CM	4	3	3.5	G-VG
					CY	4	4	4	VG
					CLN	4	4	4	VG
					CLL	3	4	3.5	G-VG
			.75	.73	CN	5	4	4.5	VG-E

TABLE 17. DATA COMPARISON RATINGS, 100% TEST (CONTINUED)

PYLON	STORE	MANEUVER	MACH WTT	MACH FLT	COEF	TREND	ACCURACY	AVERAGE	RATING
10	MK-82G	SPU	.75	.73	CM	4	4	4	VG
					CY	5	3	4	VG
					CLN	4	4	4	VG
					CLL	4	4	4	VG
11	SUU-30	AR	.65	.68	CN	4	2	3	G
					CM	4	3	3.5	G-VG
					CY	5	4	4.5	VG-E
					CLN	5	3	4	VG
					CLL	4	3	3.5	G-VG
			.75	.71	CN	4	4	4	VG
					CM	3	2	2.5	F-G
					CY	4	4	4	VG
					CLN	3	3	3	G
					CLL	2	2	2	F
		SPU	.65	.65	CN	3	1	2	F
					CM	5	4	4.5	VG-E
					CY	4	4	4	VG
					CLN	3	4	3.5	G-VG
					CLL	3	4	3.5	G-VG
			.75	.73	CN	2	1	1.5	P-F
					CM	3	2	2.5	F-G

TABLE 17. DATA COMPARISON RATINGS, 100% TEST (CONCLUDED)

			MACH		RATINGS				
PYLON	STORE	MANEUVER	WTT	FLT	COEF	TREND	ACCURACY	AVERAGE	RATING
11	SUU-30	SPU	.75	.73	CY	3	4	3.5	G-VG
					CLN	4	3	3.5	G-VG
					CLL	2	3	2.5	F-G
11	MK-82G	SPU	.65	.66	CN	2	1	1.5	P-F
					CM	2	1	1.5	P-F
					CY	1	1	1	P
					CLN	2	1	1.5	P-F
					CLL	2	1	1.5	P-F
			.75	.73	CN	2	1	1.5	P-F
					CM	2	1	1.5	P-F
					CY	1	1	1	P
					CLN	3	4	3.5	G-VG
					CLL	4	1	2.5	F-G

The results of this analysis are presented in the following paragraphs designated by pylon. In the coefficient plots, Figures 115 through 167, blank graphs indicate that flight data for comparison were not available or were of such poor quality that transmission was impossible.

5.1 Pylon 6 Comparisons

Two comparisons were made of pylon 6 store configurations: (1) 600-gallon tank, configuration 1 and (2) six SUU-30 stores on MER, configuration 4. Both configurations were tested during the 80% load demonstration flight test. The test maneuvers were strictly steady-state sideslip and symmetrical pullup which match closely the wind tunnel test conditions. Figures 115 through 118 present CN, CM, CY, and CLN for this first comparison, steady-state sideslip. Given the symmetrical configuration tested, symmetrical results for positive and negative beta sweeps could be expected. CM, CY, and CLN follow this trend, but CN digresses from the wind tunnel data at positive betas. This is not wholly unexpected since the vertical force measuring strain guages were affected by environmental temperatures during the flight tests. An attempt to correct the data was made, but it is unknown how accurate this correction procedure was. As a result, CN is suspect in this and all other comparisons. Nevertheless, this configuration, including all 4 coefficients, was given a 4.325 overall rating: 86.5% of a possible 5 points or Very Good to Excellent.

The second comparison is presented in Figures 119 through 123 with steady-state sideslip and symmetrical pullup being the tested maneuvers. The beta sweep results have a 4.06 rating or 81.2%. The coefficients CM, CY, CLN, and CLL have Very Good to Excellent ratings, but CN again rates only Fair to Good. The symmetrical pullup data follow the same general tendencies. The data scatter is quite large for CN and CY, making the rating of the data more difficult. However, the alpha sweep comparisons result in a 3.21 rating or 64.3%. Overall, comparison 2 rates only 3.57 or 71%, Good to Very Good.

5.2 Pylon 8 Comparisons

Comparison 3, Figures 124 through 128, indicates Very Good to Excellent agreement for all coefficients except CN for both the steady-state sideslip and symmetrical pullup maneuvers. The CN data follow the trends quite well but differ in magnitude, indicating that the CN correction technique may be inadequate. The overall rating is 4.39 or 87.9%, Very Good to Excellent. This is consistent with results obtained from the 600-gallon tank on pylon 6.

Figures 129 through 132 present results from comparison 4, BLU-1 unfinned store, on pylon 8. The beta sweeps at Mach 0.50 and 0.65 are from abrupt rudder maneuvers while only Mach 0.75 is from steady-state sideslip. In general, the abrupt rudder data are as good or better than the steady-state yaw data, with ratings of 3.88 and 3.53, respectively. The overall rating of comparison 4 is 3.81 or 76.1% with the moment coefficients in best agreement.

5.3 Pylon 10 Comparisons

Four comparisons are made involving pylon 10 store configurations, two from the 80% and two from the 100% loads demonstrations.

Comparison 5 is the BLU-1 unfinned store during the 80% loads flight test, Figures 133 through 137. Again, CN is the least accurate when compared to the other coefficients, especially CY, CLN, and CLL, which show Very Good to Excellent comparisons. Overall rating is 4.21 or 84.1%.

Comparison 6 is the SUU-30 store during the 80% loads flight test, Figures 138 through 142. Both CN and CM receive ratings of Fair to Very Good for both steady-state sideslip and symmetrical pullup maneuvers. This is in contrast to the Fair to Excellent comparisons for the other coefficients; CN and CM rate 3.39 or 67.7% while CY, CLN, and CLL rate 4.07 or 81.4% for an overall rating of 75.2%.

The seventh comparison is the SUU-30 store 100% loads flight test, Figures 143 through 147. Abrupt rudder and symmetrical pullup are the maneuvers tested. The trends are generally correct but the accuracy is not as consistent with the data scatter having an adverse affect on CN. The overall rating of 3.23 or 64.5% is noticeably lower than the comparable 80% loads flight test configuration of comparison 6.

Comparison 8 is the MK-82 GP store from the 100% loads flight test, Figures 148 through 152. Here, again, the data scatter is significant enough to cause lower ratings in accuracy and trend agreement. The overall rating is 3.25 or 65% which is comparable to comparison 7, also 100% flight loads test data.

5.4 Pylon 11 Comparisons

From the 80% loads flight test, comparison 9 tests the MK-82 GP store in symmetrical pullups and steady-state sideslips, Figures 153 through 157. Data from the wind tunnel test were taken on pylon 1, but modified to correspond to the sign conventions of pylon 11 in the flight test. Thus, the data are directly comparable. The results are quite disappointing for an 80% flight loads test comparison. The overall rating of 3.27 or 65.4% is comparable to the pylon 10 MK-82 GP, comparison 8, with the data scatter being of the same order of magnitude.

Comparison 10 is the MK-82 GP store in symmetrical pullups from the 100% loads flight test, Figures 158 through 162. The tested configuration differs from that of comparison 9 in that a SUU-30 is on pylon 10 in this case. The results show generally poor agreement of flight and wind tunnel data with a rating of only 34%. The data scatter does not appear to be large, but the magnitude of the flight data is quite a bit different from the wind tunnel data.

The final comparison is of the SUU-30 store on the 100% loads flight test with an adjacent MK-82 GP store on pylon 10 (comparison 8), Figures 163 through 167. Overall the comparison is much better than that of comparison 10, and at least equally as good as comparison 9. The best comparisons are of CY and CLN, ranging from Good to Very Good. The final rating is 3.25 or 65%.

5.5 Overall Comparisons

Comparisons were made of different categories of data: test maneuver, pylon, Mach number, and coefficient. These were done to identify general trends and point out problems in the data and testing and are summarized in Table 18.

The method of test, 80% loads flight test versus 100% loads flight test, has a distinct effect on the data. The 80% testing overall shows a 3.75 or 75% rating while the 100% testing indicates a 3.07 or approximately 61% rating. Although this is a significant difference, it may be an unfair comparison since no steady-state sideslip maneuvers were done during the 100% test. The steady-state sideslip maneuver presents the best data comparisons and thus may have significantly affected the 80% test ratings. The overall steady-state sideslip maneuver rating is 3.89 or 77.8%, the best of all maneuvers conducted. The abrupt rudder comparisons are rated at 3.88 (77.6%) for 80% test and 3.22 (64.4%) for the 100% test. This is a significant difference when translated into a Very Good versus Good rating favoring the 80% test. A similar trend exists in the comparisons of the symmetrical pullup maneuvers. The 80% test exhibits a 3.63 (72.6%) rating while the 100% test shows a 2.98 (59.6%) rating. These results support the conclusion that the 80% load test yields better results than the 100% test even though steady-state sideslip maneuvers were flown only during the 80% test.

The pylon location has an effect on the quality of the comparisons. Pylon 8 has the best rating at 81.2% while pylons 6 and 10 rate approximately 73% and pylon 11 the worst at 60%. These results echo the comparisons of earlier paragraphs on individual pylons.

The Mach number also has an effect on the comparison results. Mach 0.50 rates the best at 78.6% followed by Mach 0.65 at 71.6%, Mach 0.30 at 68%, and Mach 0.75 at 64.6%. The Mach number extremes present the poorest comparisons, but the differences in ratings are not particularly significant. When considering that the flight test Mach numbers do not exactly match the wind tunnel test Mach numbers, this becomes more apparent. The average flight test Mach number, 0.39, is compared to a wind tunnel Mach of 0.30. To compare 0.50 Mach wind tunnel data, 0.48 flight Mach was used; 0.65 versus 0.63; and finally 0.75 versus 0.72. Although these Mach variations may not be large, they could account for some of the differences between the 78.6% rating at 0.50 Mach and the 64.6% rating at 0.75 Mach.

Finally, the aerodynamic coefficient tested for yields significant differences in comparison quality. The side force and moment, CY and CLN show the best comparisons at 76% and 83.6%, respectively. Pitching moment at 69.6%, roll moment at 62.6% and 61.6% are significantly less. Since steady-state sideslip and abrupt rudder are the two highest rated maneuvers, it is not surprising that the best rated coefficients are CY and CLN. The poor showing of CN can be attributed to the instrumentation problem and data correction procedure discussed in subsection 5.1.

TABLE 18. OVERALL DATA COMPARISONS

COMPARISON	RATING
TEST TYPE	
80%	3.75 (75%)
100%	3.07 (61%)
MANEUVER	
STEADY-STATE SIDESLIP	3.89 (78%)
ABRUPT RUDDER (80%)	3.88 (78%)
ABRUPT RUDDER (100%)	3.22 (64%)
SYMMETRICAL PULLUP (80%)	3.63 (73%)
SYMMETRICAL PULLUP (100%)	2.98 (60%)
PYLON	
6	3.62 (72%)
8	4.06 (81%)
10	3.65 (73%)
11	3.02 (60%)
MACH	
0.30	3.40 (68%)
0.50	3.93 (80%)
0.65	3.58 (71%)
0.75	3.23 (65%)
COEFFICIENT	
CN	3.08 (61%)
CM	3.48 (70%)
CY	3.80 (76%)
CLN	4.18 (83%)
CLL	3.13 (63%)

SECTION VI

CONCLUSIONS

The main conclusions drawn from this analysis are:

1. Hysteresis effects are present when testing the A-10 aircraft for store carriage airloads. The largest effects are at the most outboard pylons (1, 2, 10, 11), at Mach 0.75, and zero degrees alpha. The effects can be minimized by consistent data taking procedure. The preferred method of taking data was determined to be from negative to positive beta for beta sweeps, with no preferred method for alpha sweeps.

2. Adjacent store effects are prevalent throughout the majority of cases tested. Stores cannot be tested to obtain independent data in the following cases:

   a. Any combination of outboard pylons.

   b. Any combination of inboard pylons.

   c. Adjacent pylon across a landing gear fairing.

The impact of these adjacent pylon effects will vary depending upon the analysis in which the data are used. It is necessary to make judgments from the data in Reference 6 depending on specific data accuracy requirements.

3. The wind tunnel data taken with the 5% A-10 aircraft/store models and the flight test data show Good to Very Good agreement. This holds true for various maneuvers, Mach numbers, pylon locations and aerodynamic coefficients.

SECTION VII

RECOMMENDATIONS

Based on the conclusions drawn from this analysis, the following recommendations are presented:

1. All future carriage airloads testing on the 1/20 scale A-10 aircraft should be done using the negative to positive angle data taking method for both α and β.

2. Additional wind tunnel tests should be conducted with longer time increments between data points to assure that the data is repeatable and is independent of the time increments size. Both negative to positive and positive to negative data sweeps should be performed to see if the hysteresis effects are time increment dependent. Investigation into the data jump phenomenon seen in some of the data could be done as a part of this proposed test.

3. Carriage airloads testing of stores on the 5% A-10 aircraft should not be done on adjacent pylons if independent data are required. It is recommended that a maximum of three pylon locations be tested independently, one on each wing outside of the landing gear fairing and one inboard of the fairings. Stores inboard and outboard of the fairing immediately adjacent to the fairing should not be considered independent.

4. Additional wind tunnel testing should be done to expand the adjacent store data base to include combinations not tested here. For examples, pylon 4 versus pylon 8 effects considered only multiple stores and effects across the landing gear fairing are known only for pylons 4 versus 5 and 8 versus 9.

5. Additional analysis should be done with the current data to further define the adjacent store effects. Level 1, 2, and 3 limits were chosen quite arbitrarily and need to be defined for some standard analyses. Store separation trajectories could be run for various adjacent store effects until appreciable effects are evident. The magnitude of the adjacent store effects inputted compared to actual adjacent store effects obtained from test would allow refinement of the exceedance levels. Other analyses, such as structural analyses using carriage airloads data and stability and control analyses, would provide additional exceedance level definition.

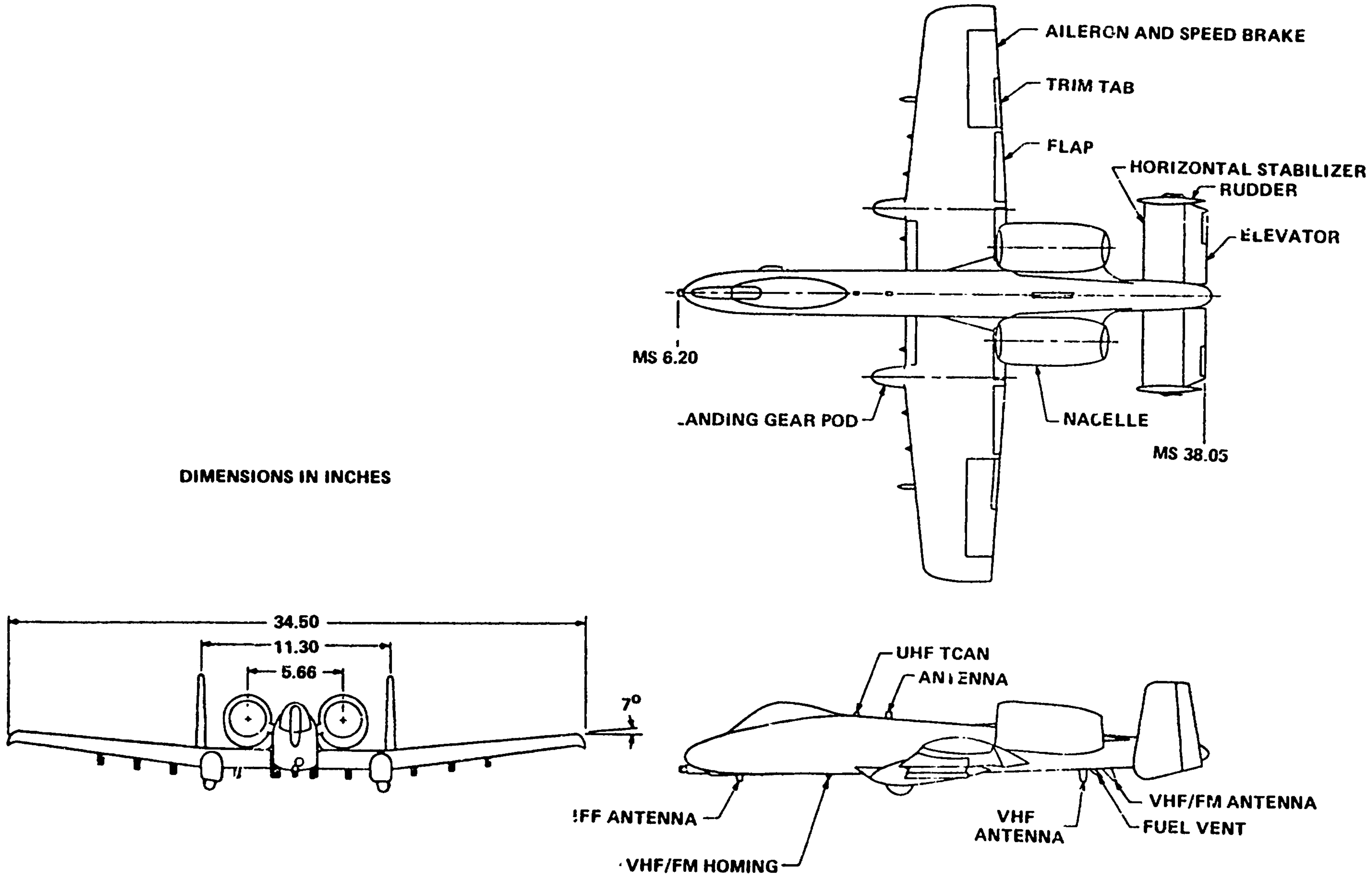


Figure 1. 0.05-Scale Aircraft Model

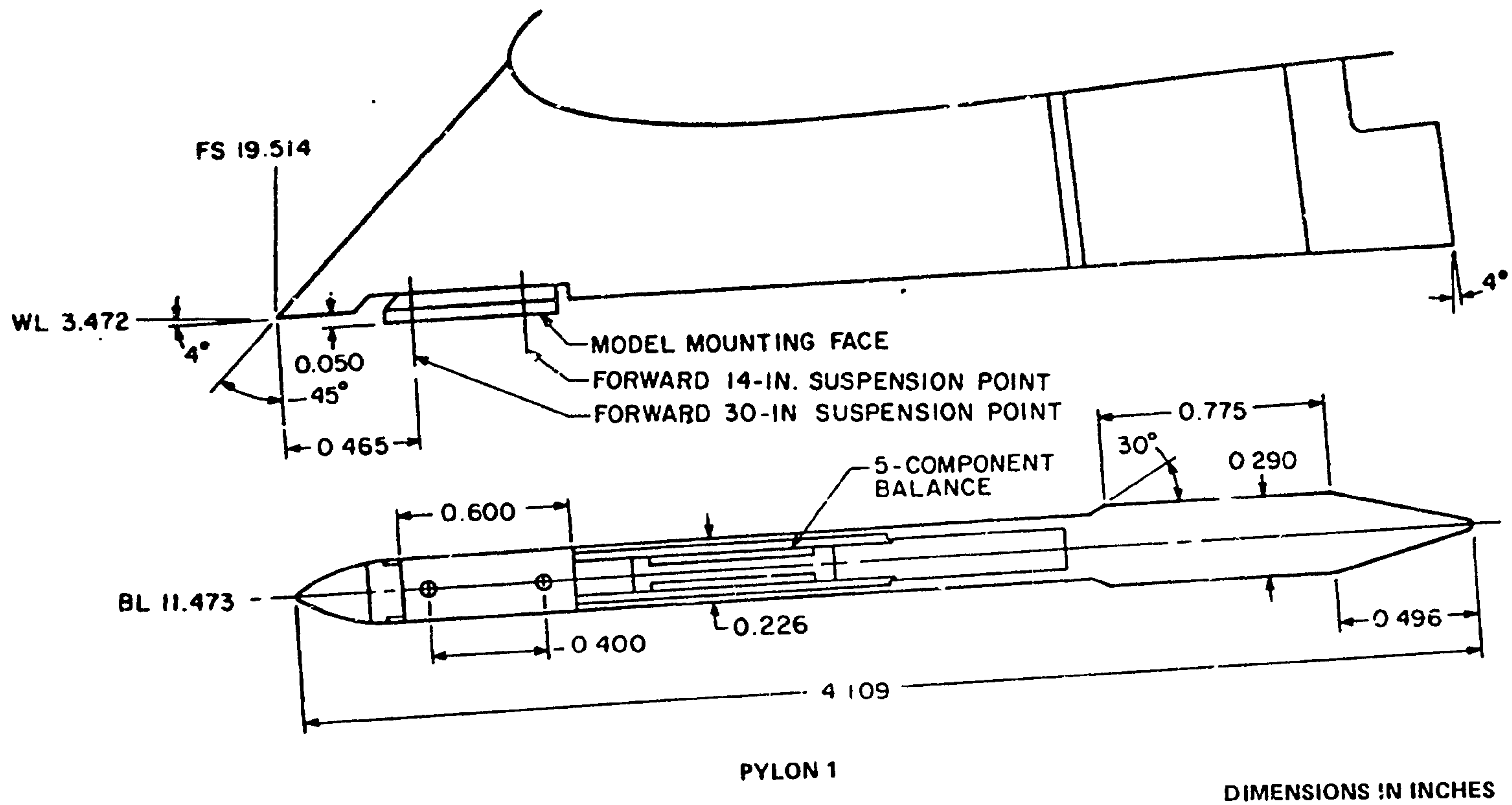
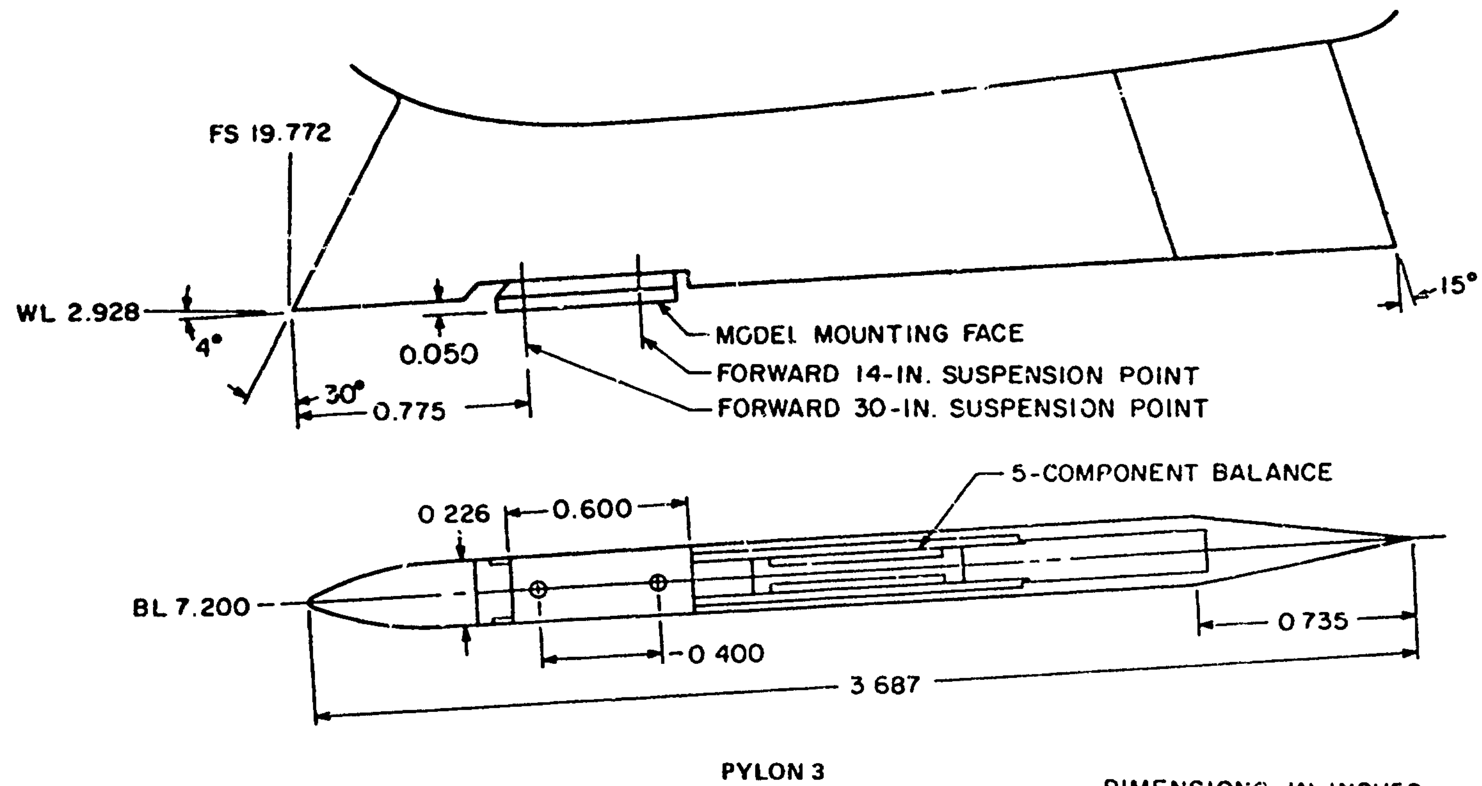


Figure 2. A-10 Aircraft Pylon Details



DIMENSIONS IN INCHES

Figure 2. A-10 Aircraft Pylon Details (Continued)

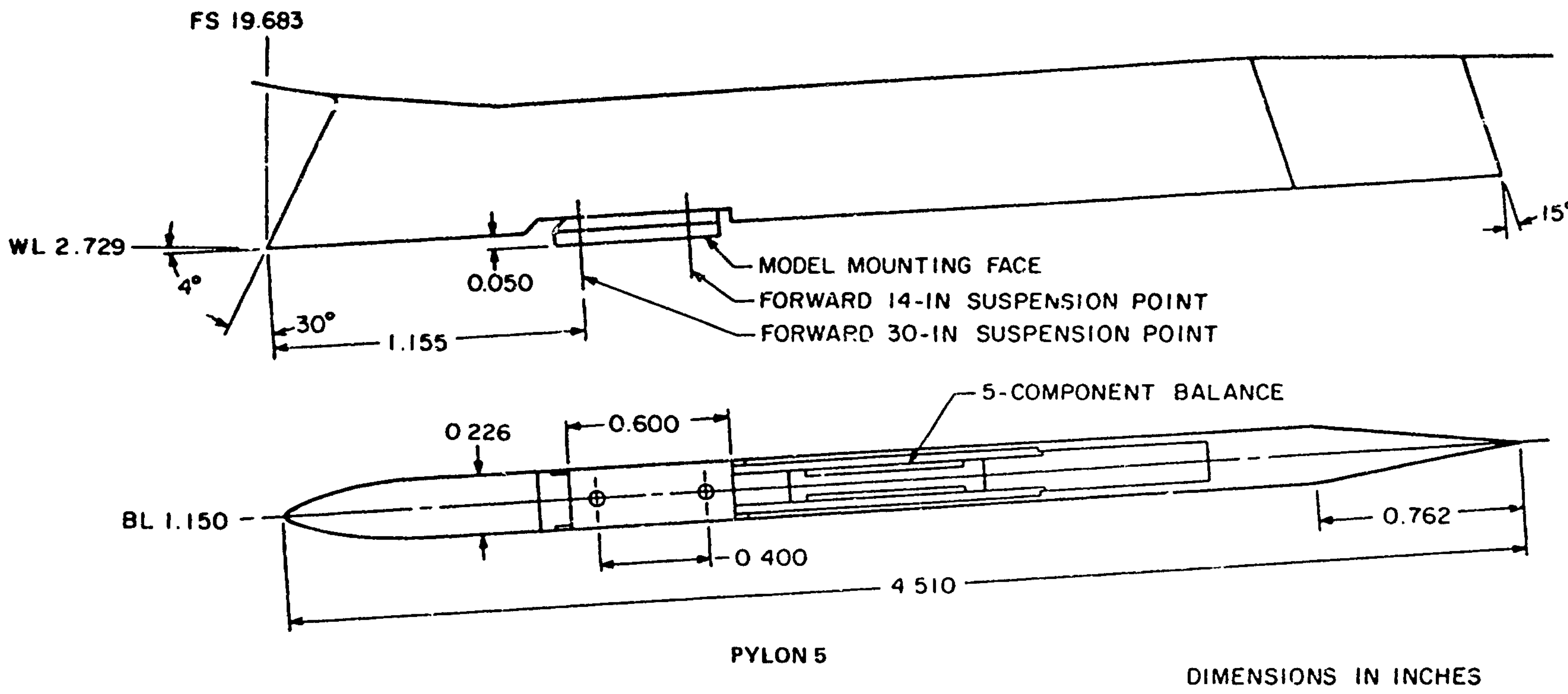


Figure 2. A-10 Aircraft Pylon Details (Continued)

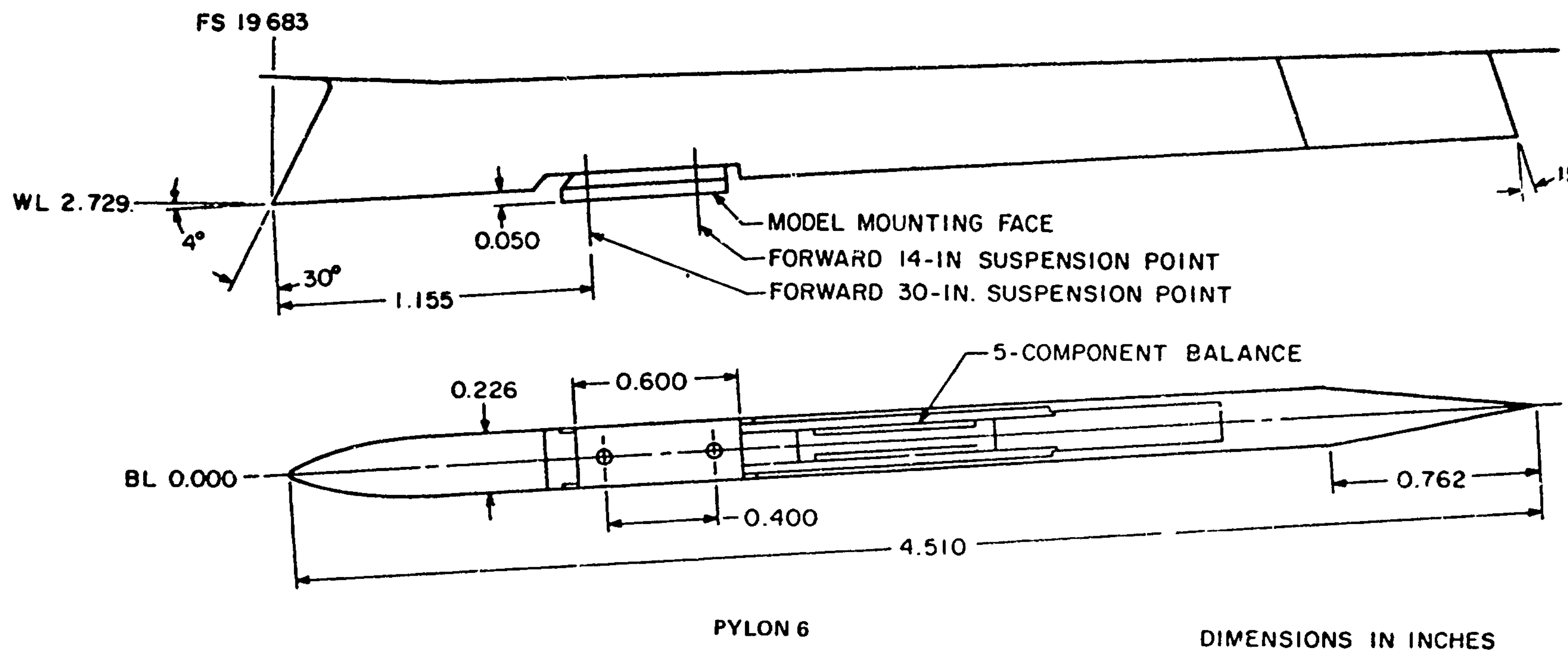


Figure 2. A-10 Aircraft Pylon Details (Continued)

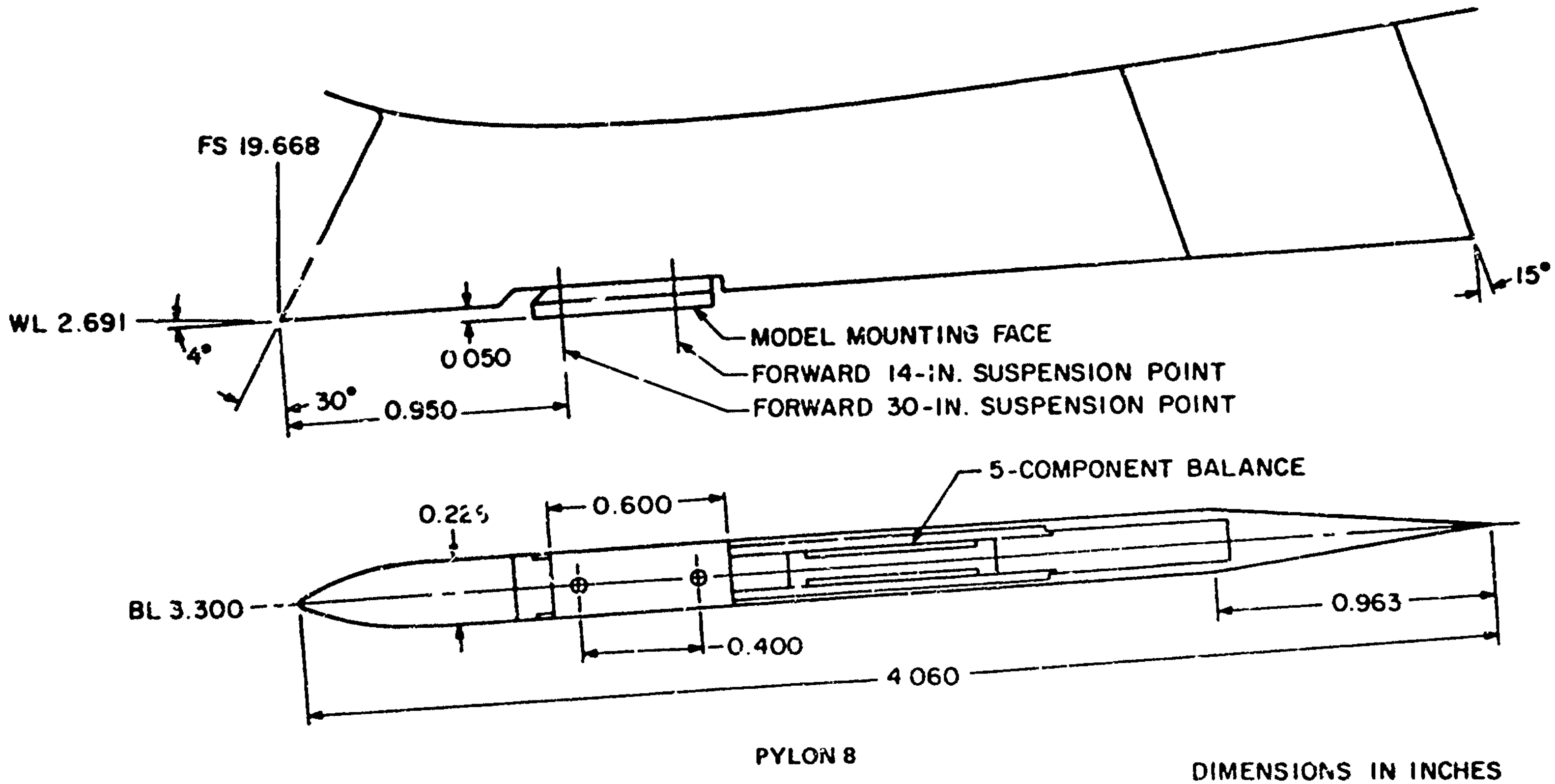


Figure 2. A-10 Aircraft Pylon Details (Continued)

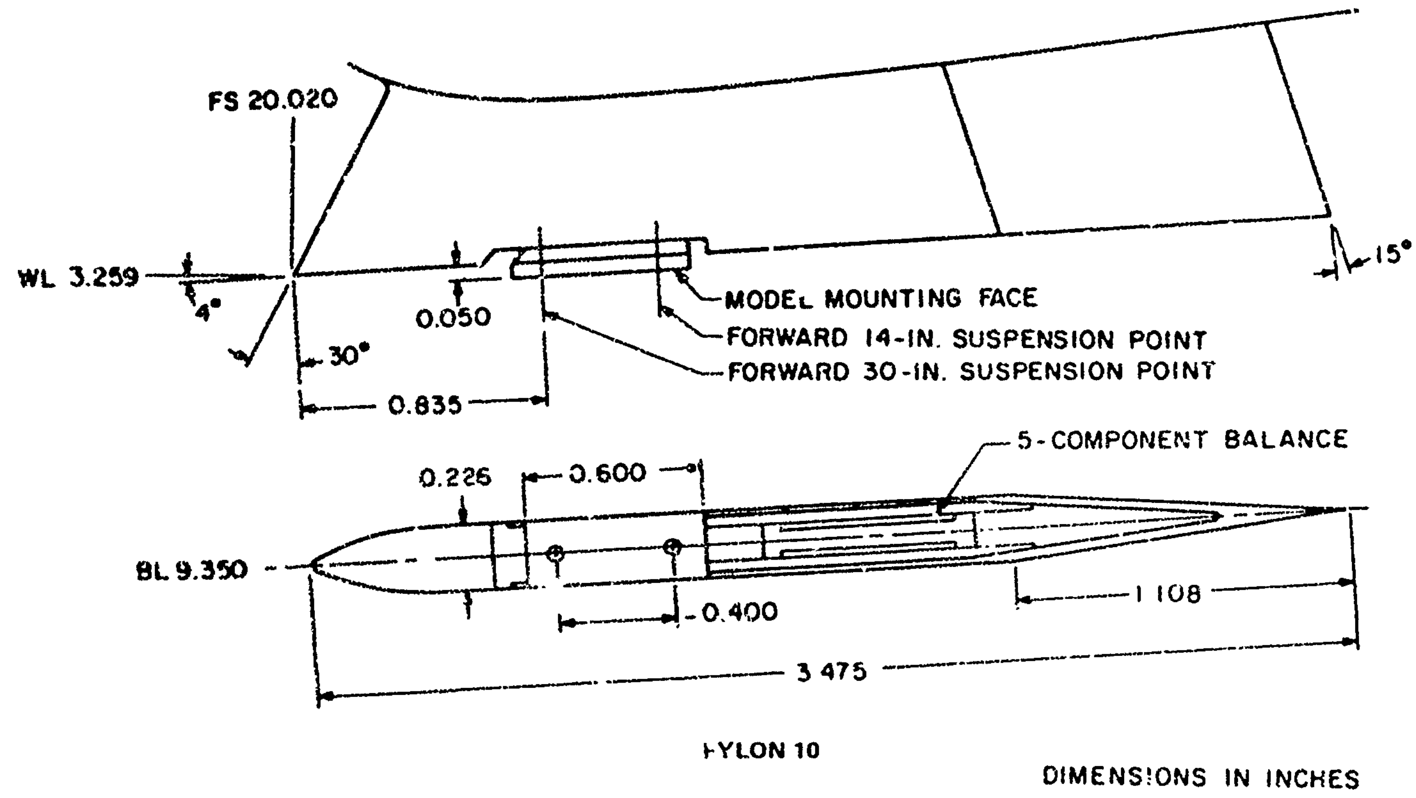


Figure 2. A-10 Aircraft Pylon Details (Concluded)

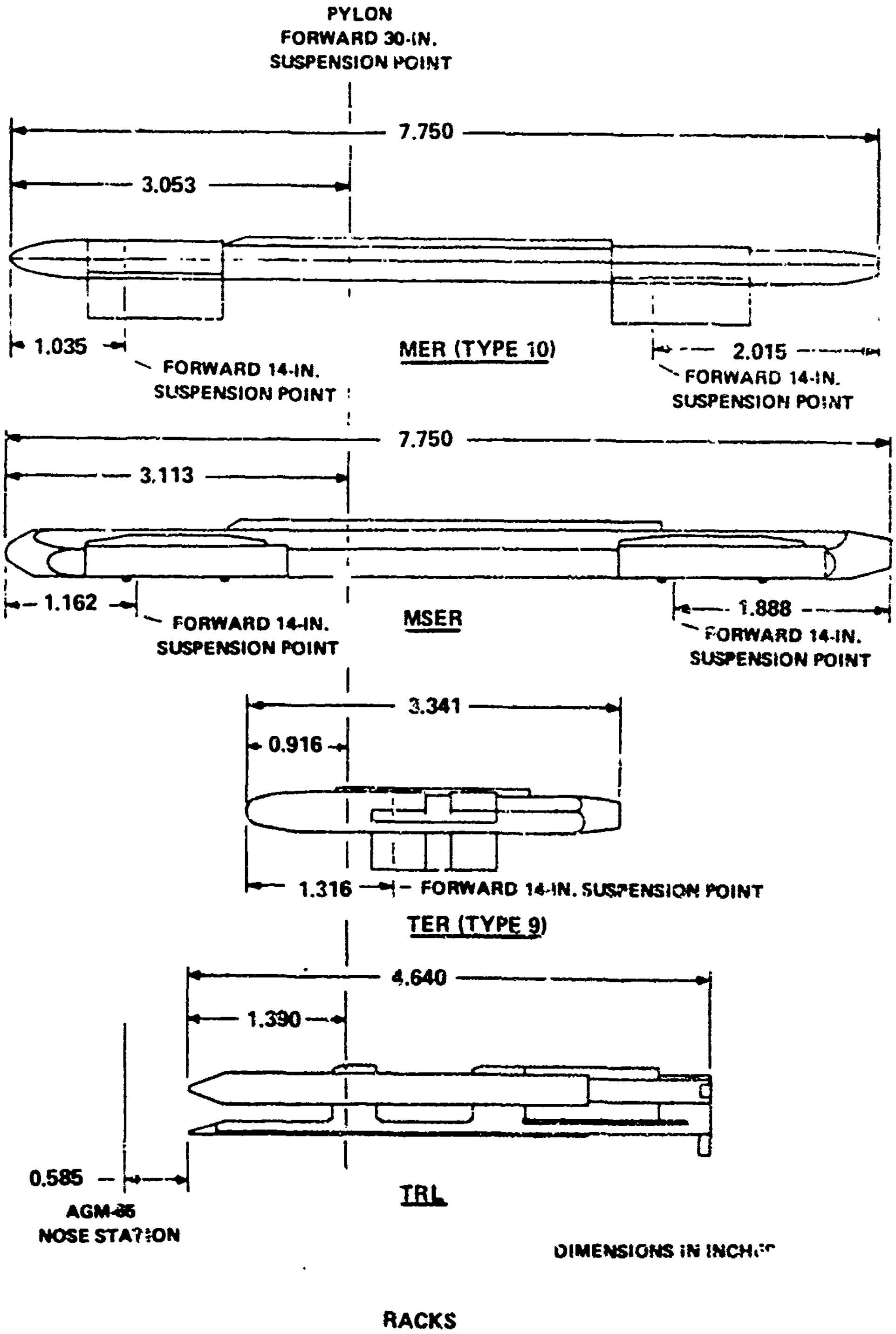


Figure 3. 0.05-Scale External Stores and Racks

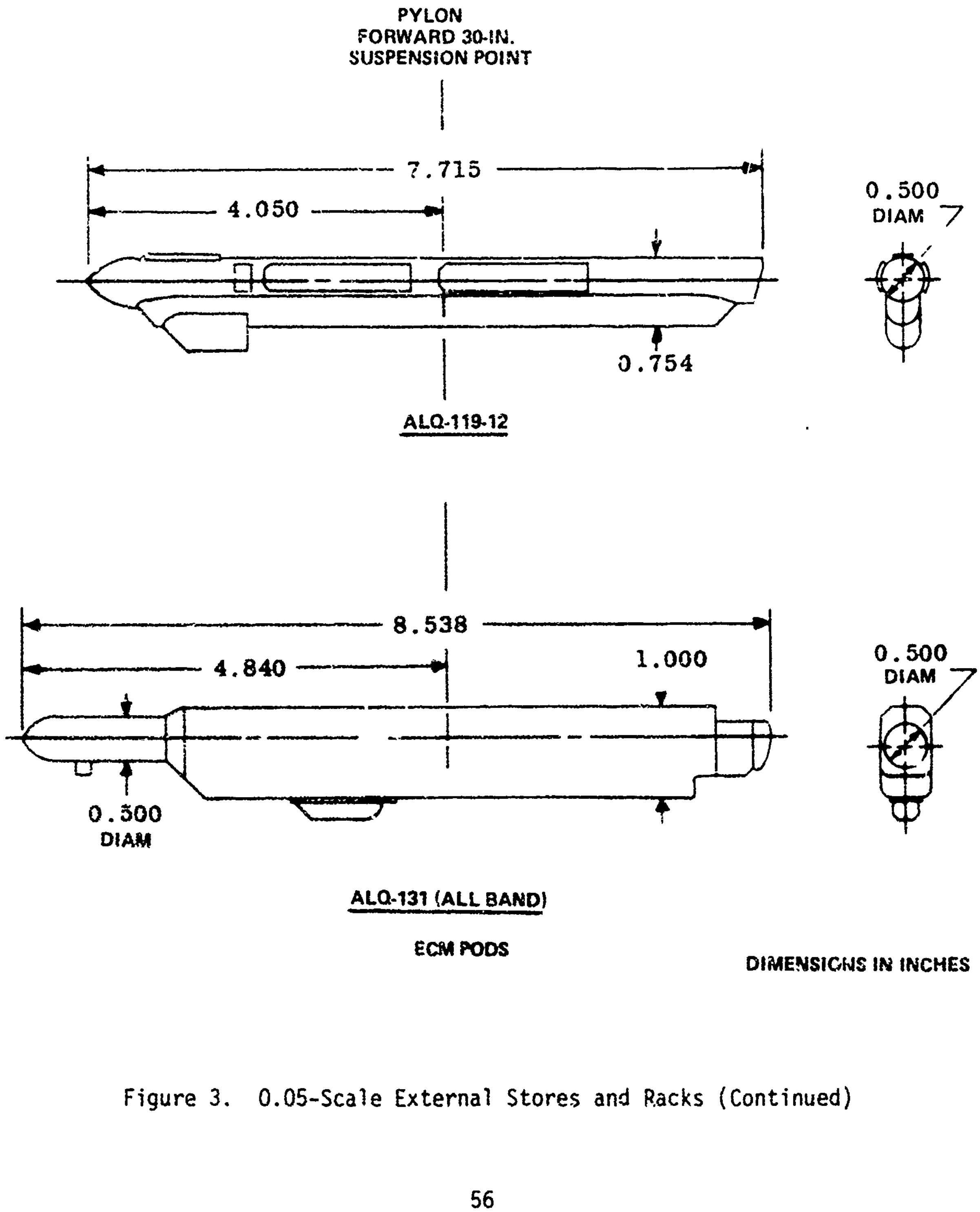
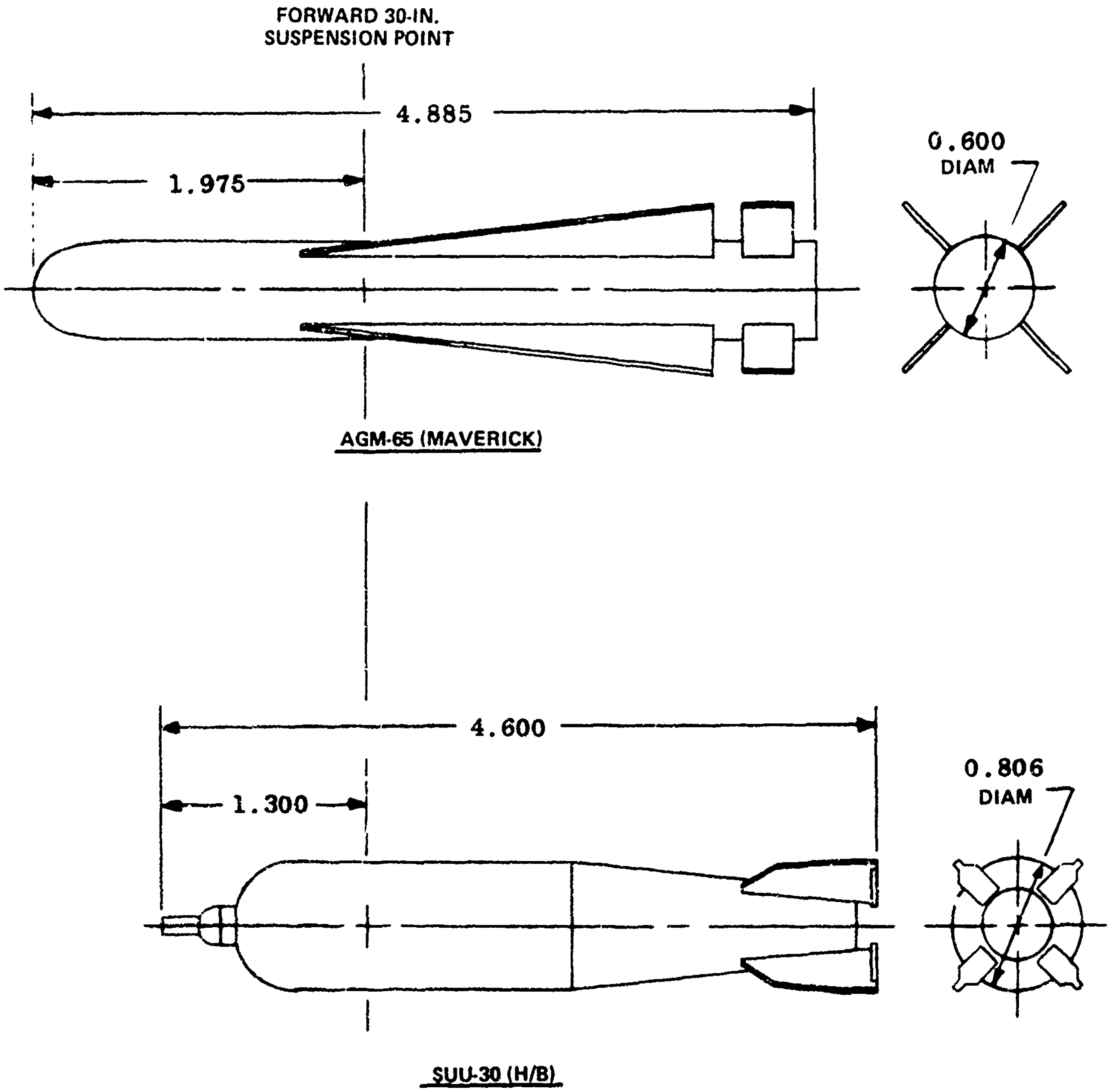


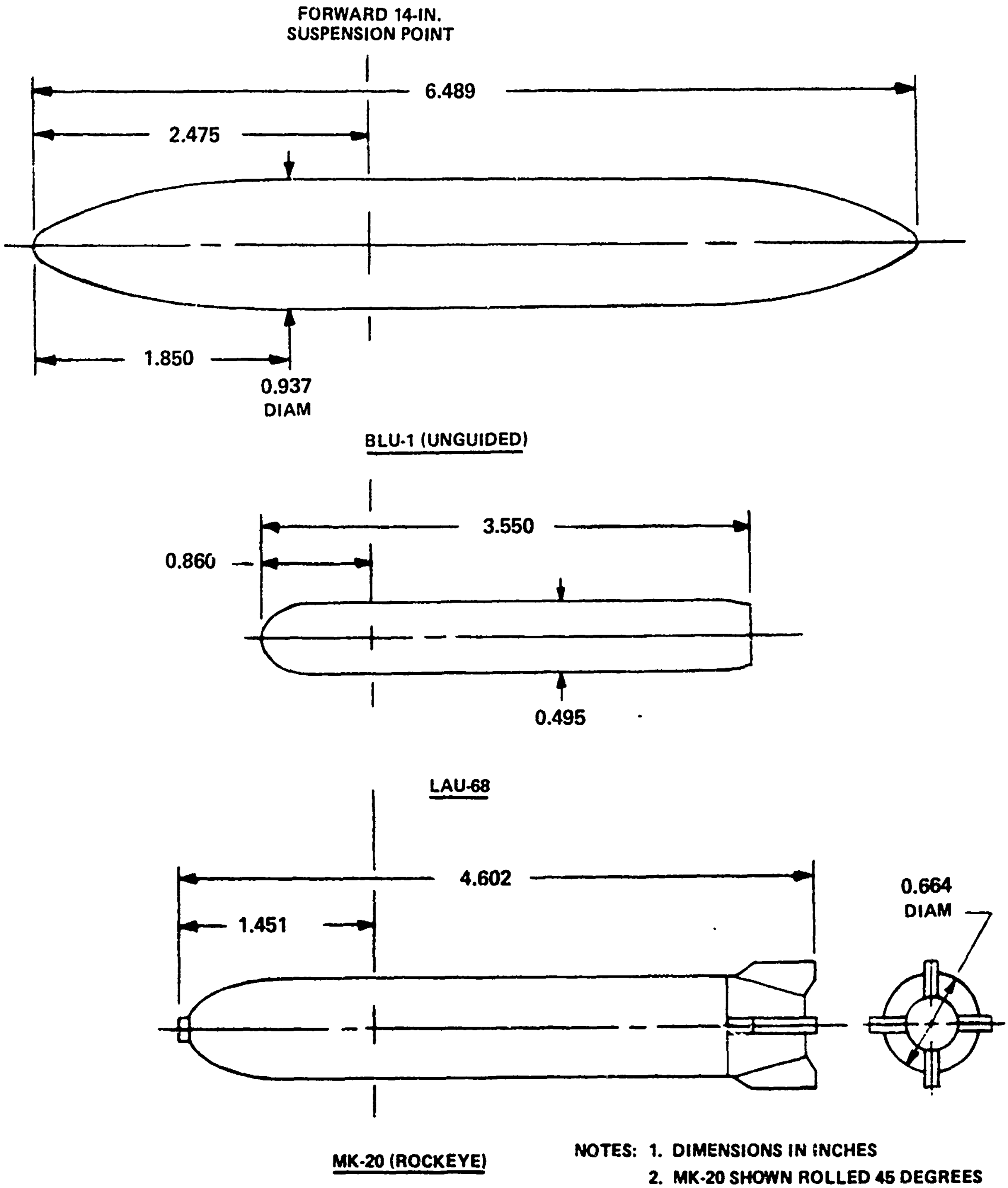
Figure 3. 0.05-Scale External Stores and Racks (Continued)



DIMENSIONS IN INCHES

AGM-65 and SUU-30 (H/B)

Figure 3. 0.05-Scale External Stores and Racks (Continued)



BLU-1, LAU-68 and MK-20

Figure 3. 0.05-Scale External Stores and Racks (Continued)

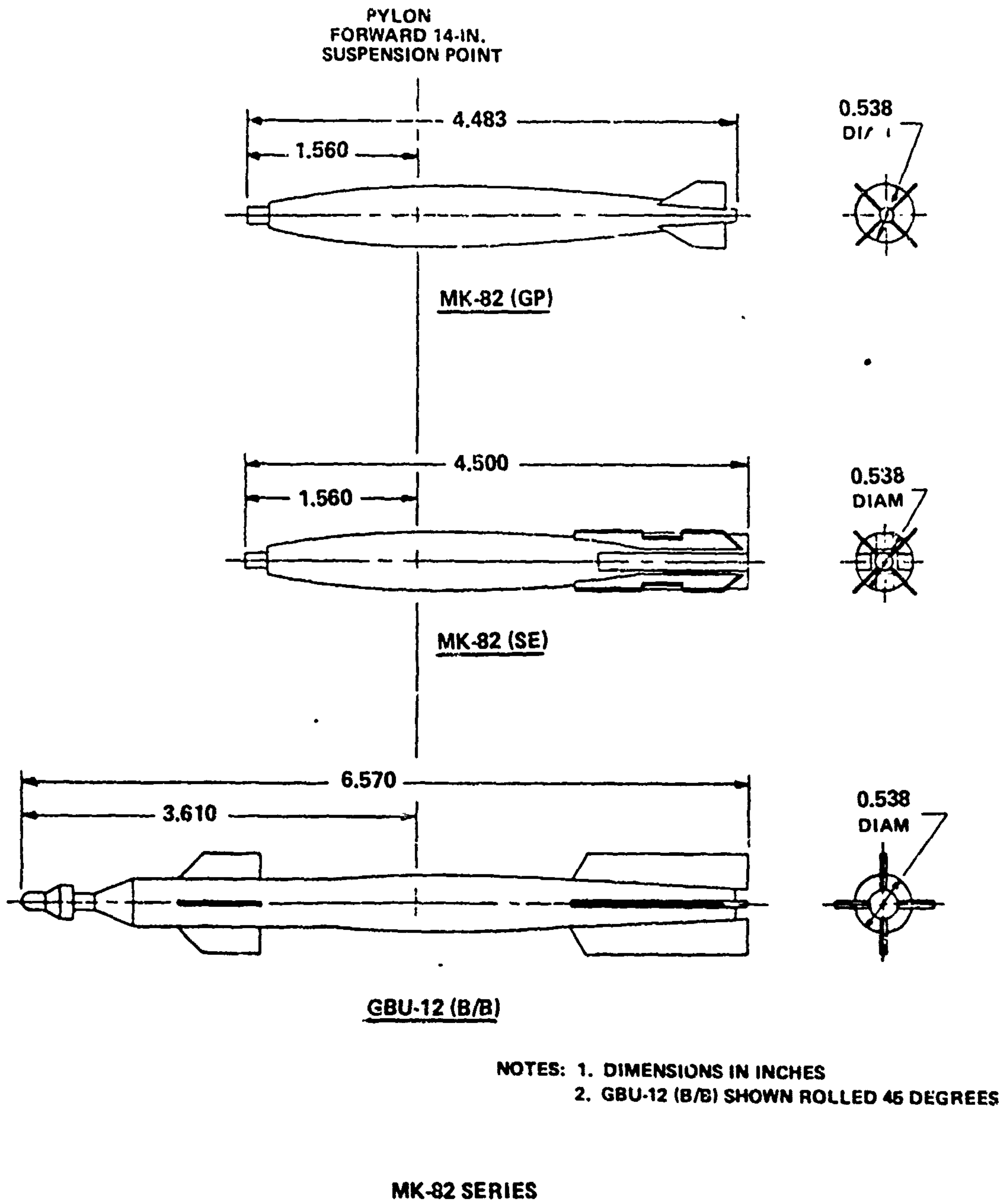


Figure 3. 0.05-Scale External Stores and Racks (Continued)

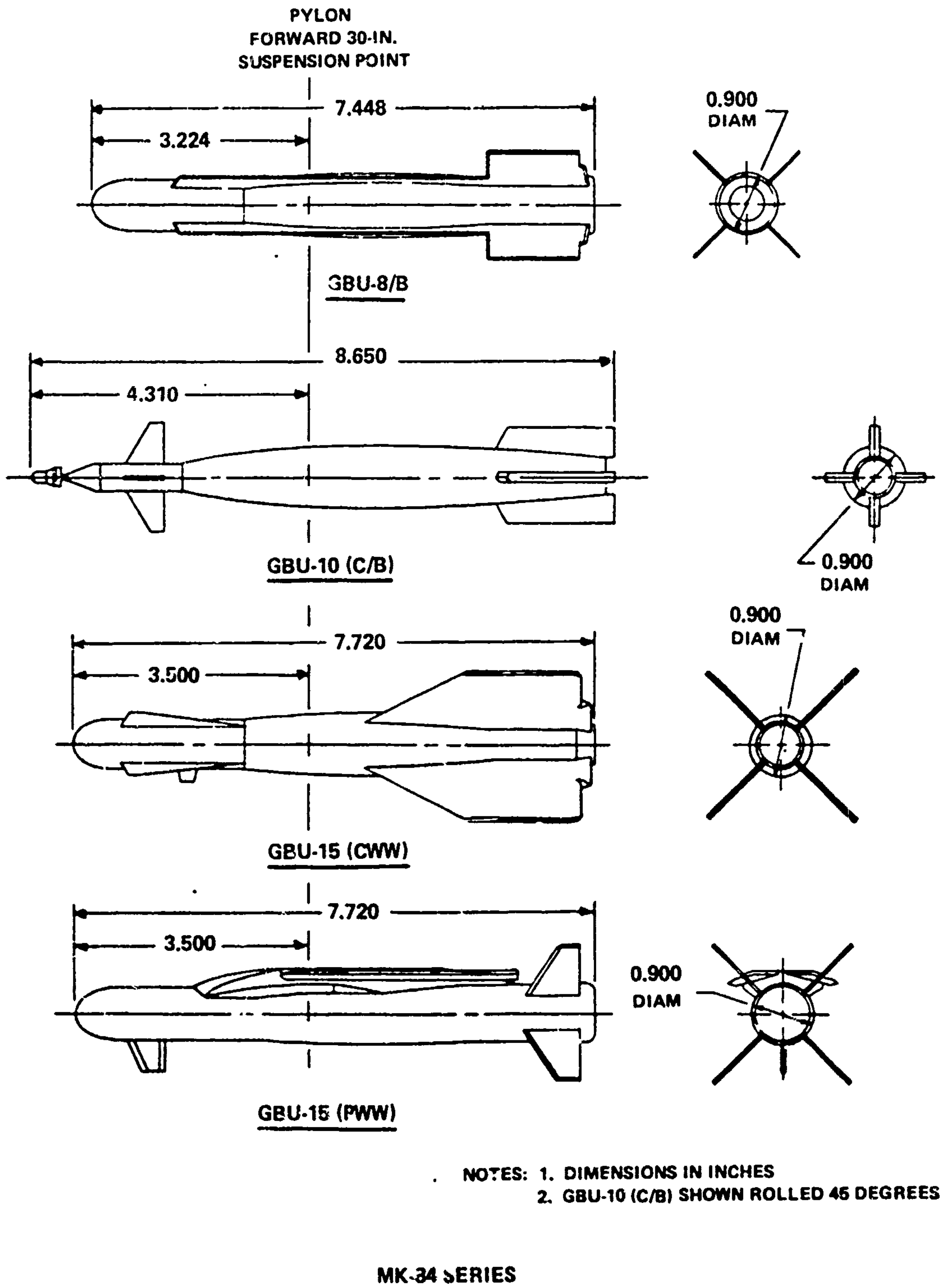
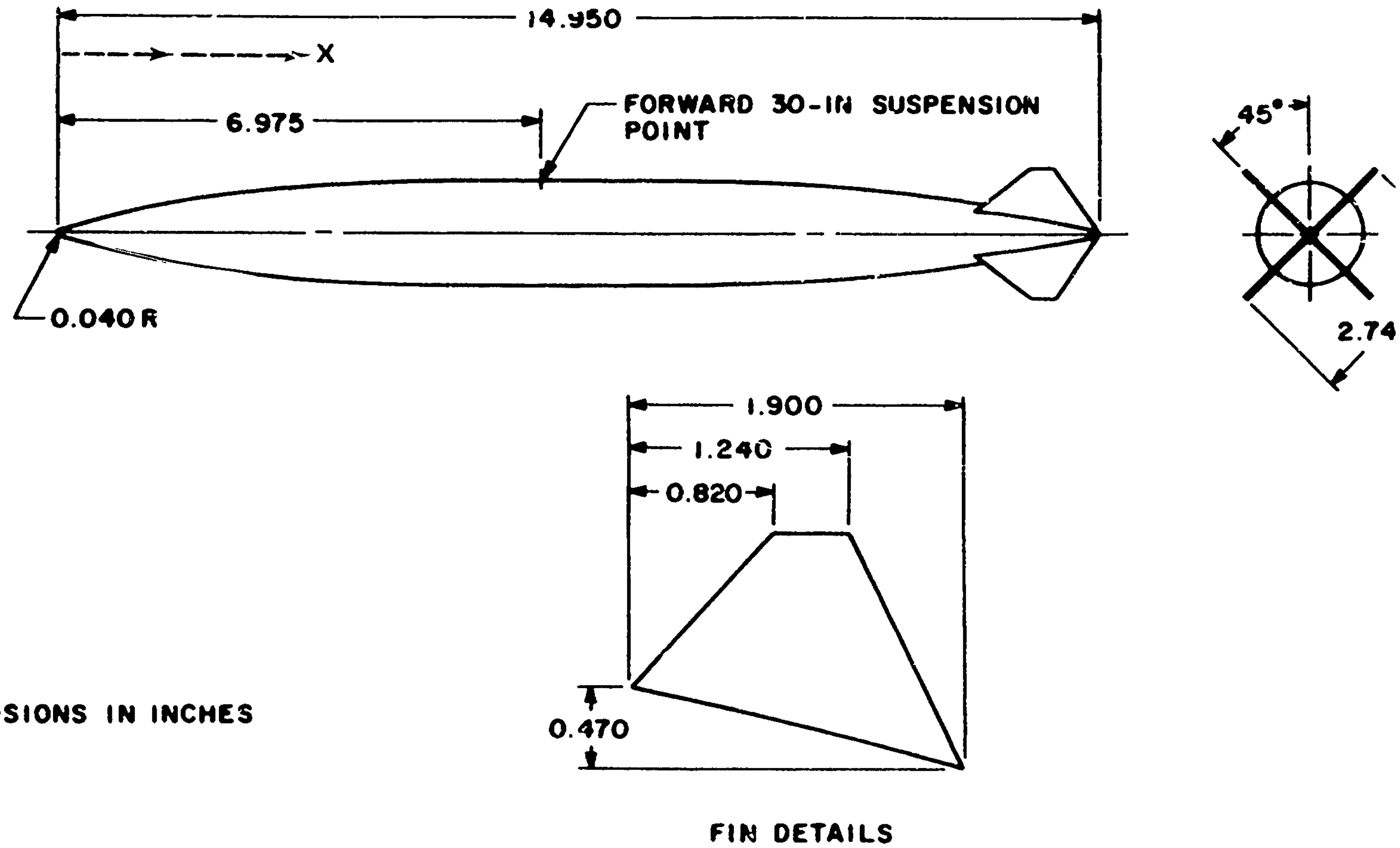


Figure 3. 0.05-Scale External Stores and Racks (Continued)

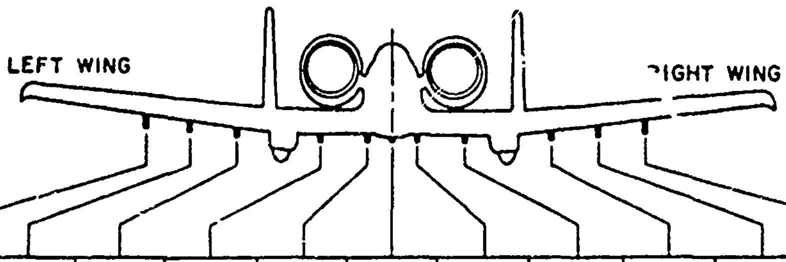
X	DIAM.
0	0
1	0.583
2	0.986
3	1.276
4	1.460
5	1.536
6	1.536
7	1.536
8	1.536
9	1.532
10	1.527
11	1.460
12	1.267
13	0.969
14	0.558



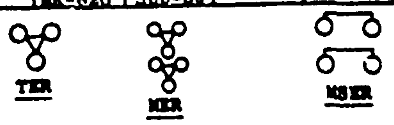
DIMENSIONS IN INCHES

600-GALLON TANK

Figure 3. 0.05-Scale External Stores and Racks (Concluded)



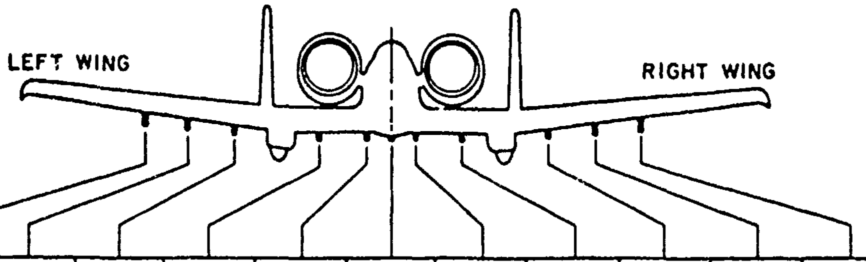
CONFIG NO.	PYLON 1	PYLON 2	PYLON 3	PYLON 4	PYLON 5	PYLON 6	PYLON 7	PYLON 8	PYLON 9	PYLON 10	PYLON 11
1				600-Gal Tank		600-Gal Tank		600-Gal Tank			
2	ALQ-119			SUU-30		SUU-30		SUU-30			
3	ALQ-131			SUU-30	SUU-30		SUU-30	SUU-30			
4				BLU-1		SUU-30		BLU-1		SUU-30	
5	MK-82G			SUU-30	SUU-30				SUU-30	SUU-30	
6	MK-82G	MK-82G			SUU-30					SUU-30	SUU-30
7		MK-82G	MK-82G		SUU-30		SUU-30			SUU-30	
8			GBU-15C	MK-82G					SUU-30	SUU-30	
9			GBU-15C					MK-20		SUU-30	
10		MK-82G	GBU-15C				MK-20	MK-20			
11			SUU-30	MK-20				MK-20			
12		MK-82G	SUU-30					MK-20	SUU-30		



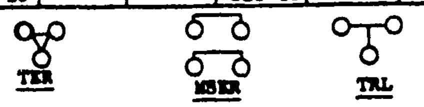
NOTE: DARK SYMBOLS INDICATE METRIC PYLONS

CONFIGURATIONS 1 THROUGH 12

Figure 4. Wind Tunnel Test Configuration Key



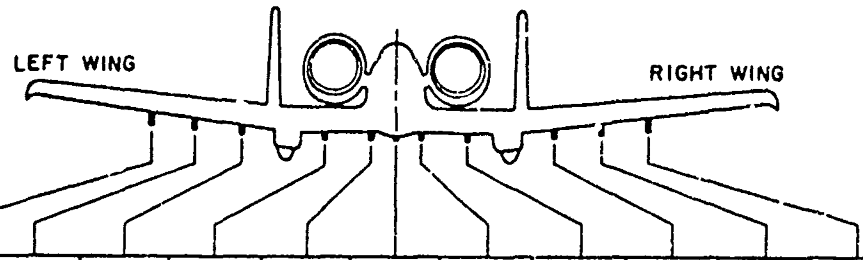
CONFIG NO.	PYLON 1	PYLON 2	PYLON 3	PYLON 4	PYLON 5	PYLON 6	PYLON 7	PYLON 8	PYLON 9	PYLON 10	PYLON 11
13			SUU-30					MK-20	SUU-30		
14			SUU-30	MK-20				MK-20			
15	MK-82G		SUU-30					MK-20		SUU-30	
16			MK-82G				MK-82S	MK-20			
17	GBU-12	LAU-68			MK-82S		MK-82S				
18	GBU-12			MK-82S	MK-82S				GBU-15C	BLU-1	
19	SUU-30	MK-82G			MK-82S					BLU-1	
20	SUU-30			MK-82S	MK-82G					MK-82G	
21	SUU-30	SUU-30			MK-82G		MK-82S			MK-82G	MK-82G
22	MK-82G	SUU-30			MK-82G				MK-82G	MK-82G	MK-82G
23	MK-20			GBU-10	GBU-10				MK-82G	MK-82G	
24	MK-20	MK-20			GBU-10				AGM-65	MK-82G	



NOTE: DARK SYMBOLS INDICATE METRIC PYLONS

CONFIGURATIONS 13 THROUGH 24

Figure 4. Wind Tunnel Test Configuration Key (Continued)

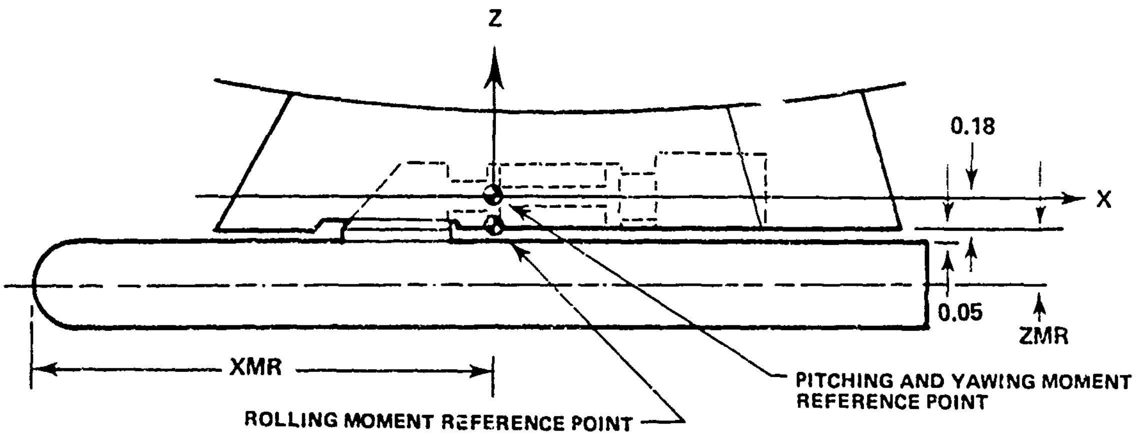


CONFIG NO	PYLON 1	PYLON 2	PYLON 3	PYLON 4	PYLON 5	PYLON 6	PYLON 7	PYLON 8	PYLON 9	PYLON 10	PYLON 11
25	MK-20	SUU-30			GBU-10		GBU-10		SUU-30	MK-82G	
26			GBU-10	GBU-10	GBU-10		GBU-10	GBU-10			
27			GBU-10					GBU-10			
28	MK-82G		GBU-10					GBU-10	GBU-10		
29			AGM-65	GBU-10				GBU-10	AGM-65		
30	MK-82G	MK-82G	AGM-65	MK-82G	MK-82G		MK-82G	MK-82G	AGM-65	MK-82G	MK-82G
31	SUU-30	SUU-30	AGM-65	SUU-30	SUU-30		SUU-30	SUU-30	AGM-65	SUU-30	SUU-30
32			AGM-65				SUU-30	LAU-68	SUU-30	SUU-30	SUU-30
33			GBU-15P					GBU-8			
34		SUU-30	GBU-15P					GBU-8	GBU-8		
35	MK-82G		MK-82G					GBU-12			
36	GBU-12		MK-82G				GBU-12	GBU-12			

NOTE: DARK SYMBOLS INDICATE METRIC PYLONS

CONFIGURATIONS 25 THROUGH 36

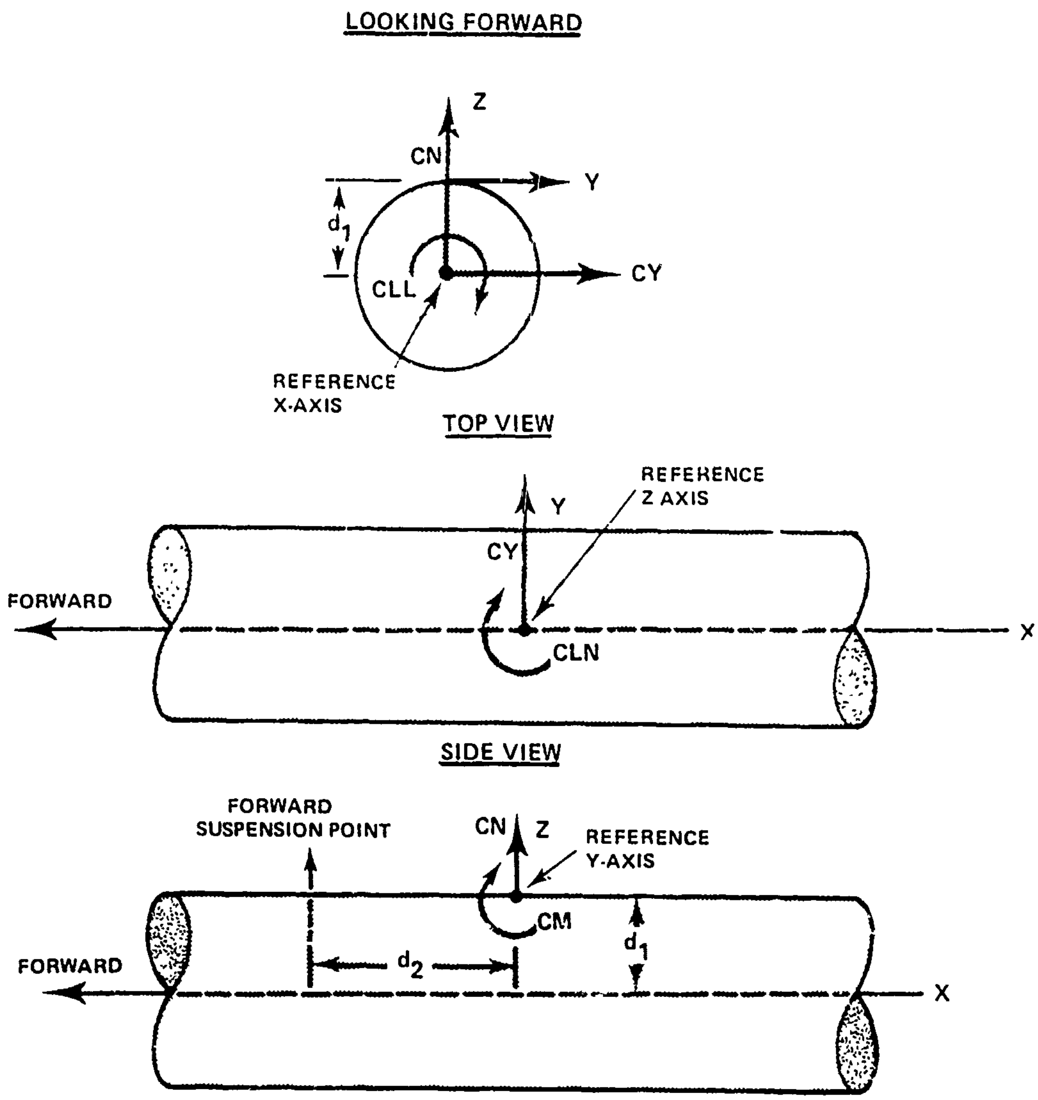
Figure 4. Wind Tunnel Test Configuration Key (Concluded)



Sign Convention:

CN	+	Up
CM	+	Nose Up
CY	+	Right
CLN	+	Nose Right
CLL	+	Roll Right

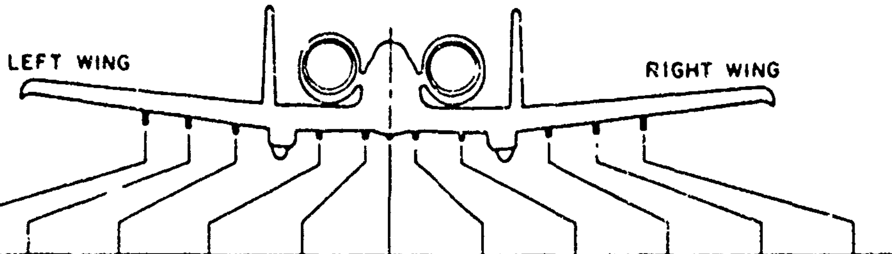
Figure 5. Wind Tunnel Test Axis System



Sign Convention:

CN	+	Up
CM	+	Nose Up
CY	+	Right
CLN	+	Nose Right
CLL	+	Roll Right

Figure 6. Flight Test Axis System



CONFIG NO	PYLON 1	PYLON 2	PYLON 3	PYLON 4	PYLON 5	PYLON 6	PYLON 7	PYLON 8	PYLON 9	PYLON 10	PYLON 11	
1	○ MK-82G				○ SUU-23		● SUU-23				● MK 82G	
2				○ 600-GAL TANK		● 600-GAL TANK		● 600-GAL TANK				
3		○ SUU-30		○ BLU-1		SUU-30		● BLU-1		● SUU-30		80% SURVEY
4		○ BLU-1								● BLU-1		
5	○ SUU-30	○ SUU-30								● SUU-30	● SUU-30	100% SURVEY
6	○ MK-82G	○ MK-82G								● MK-82G	● MK-82G	

MER

NOTE: DARK SYMBOLS INDICATE METRIC PYLONS

Figure 7. Aircraft Loading Flight Test Configuration Key

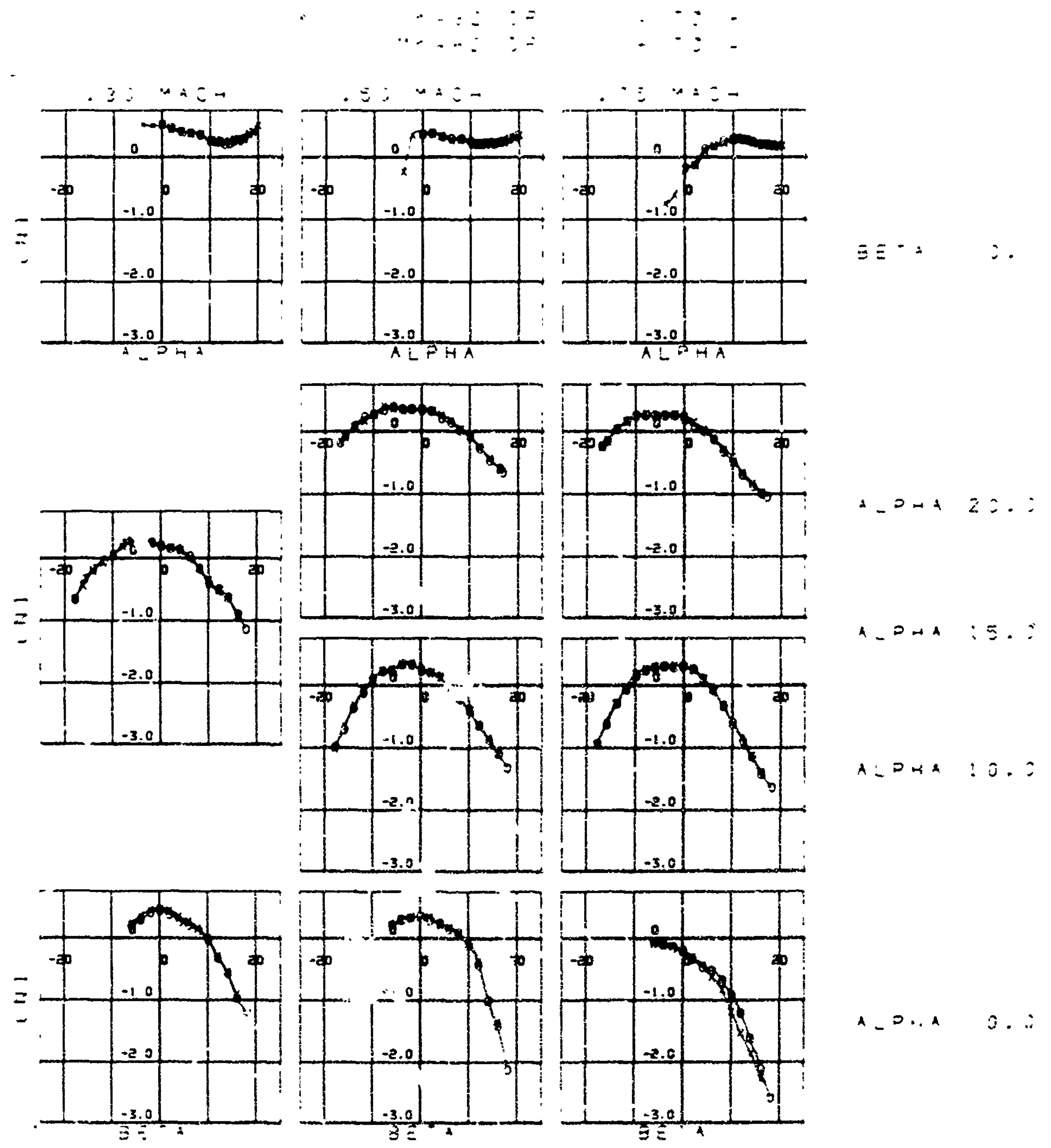


Figure 8. Hysteresis Data, CN, Pylon 1, Configuration 30

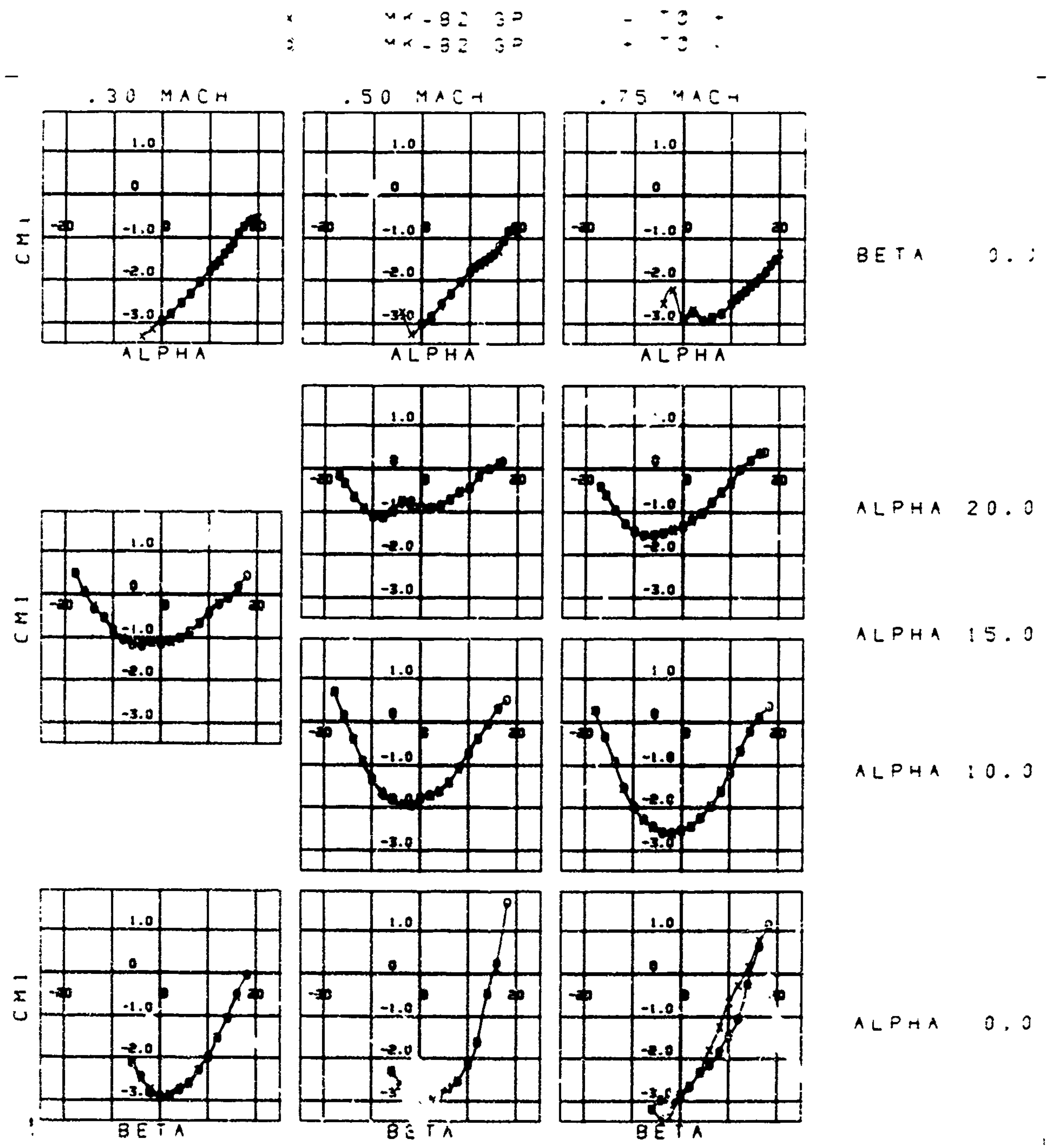


Figure 9. Hysteresis Data, CM, Pylon 1, Configuration 30

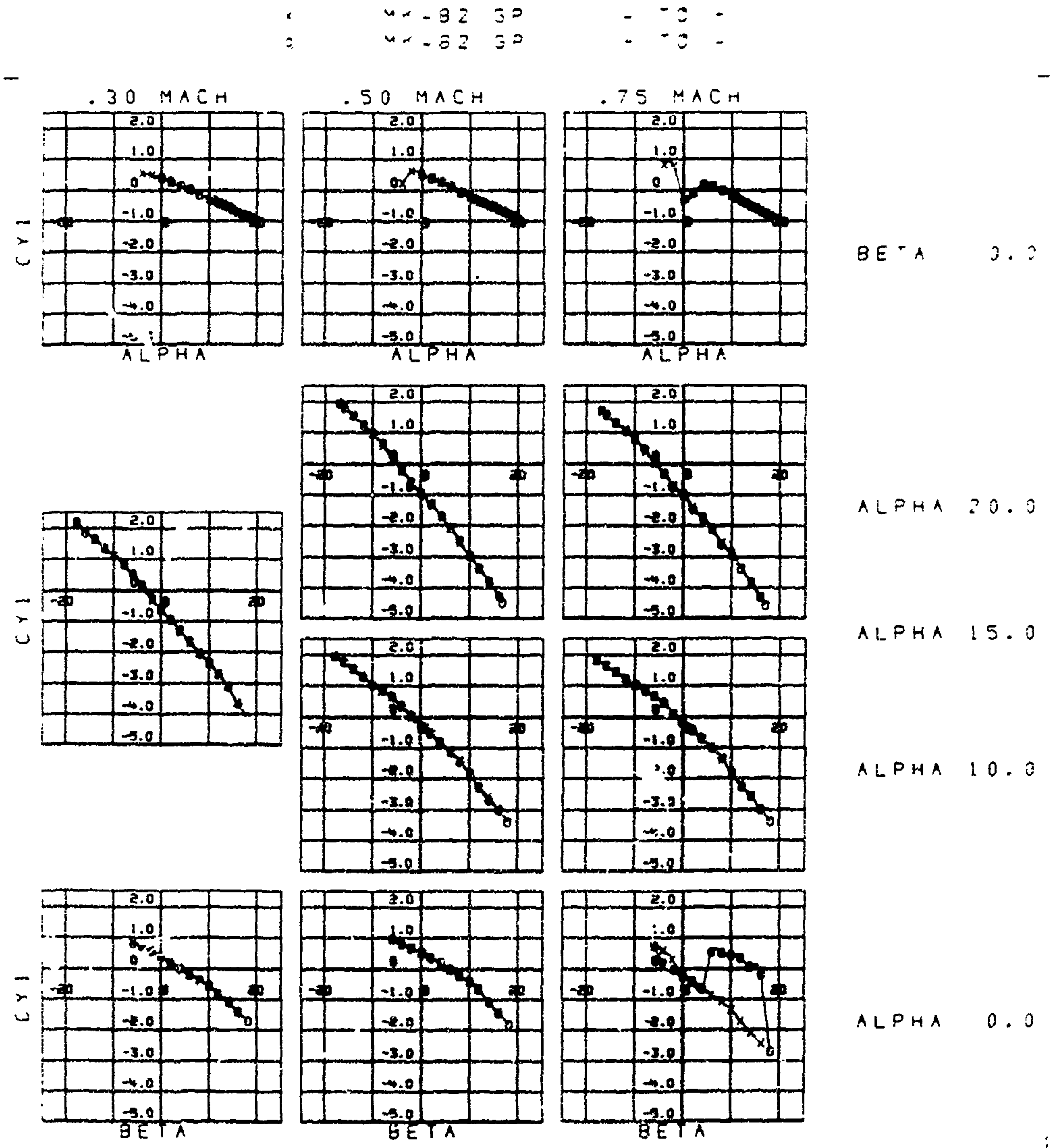


Figure 10. Hysteresis Data, CY, Pylon 1, Configuration 30

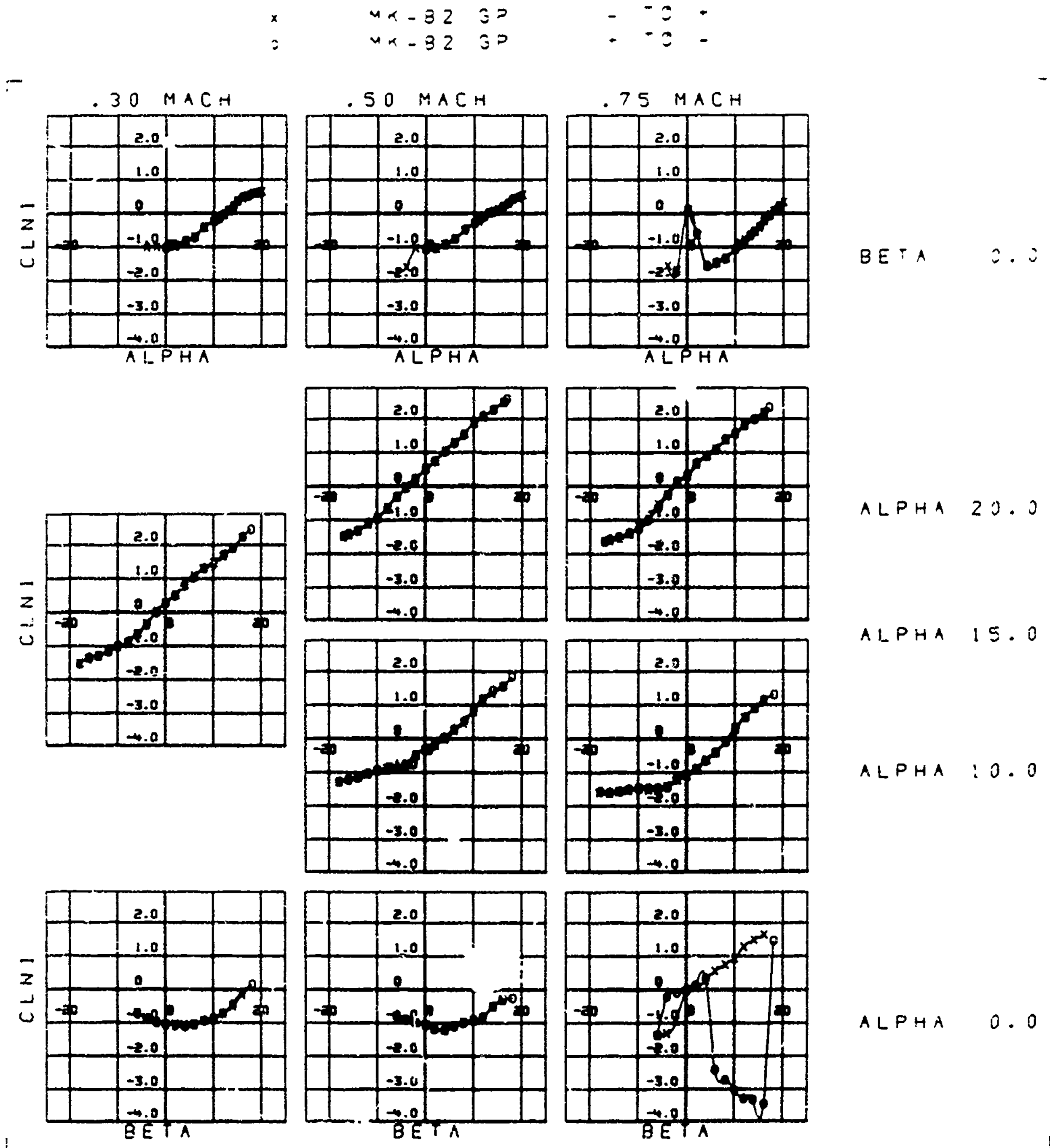


Figure 11. Hysteresis Data, CLN, Pylon 1, Configuration 30

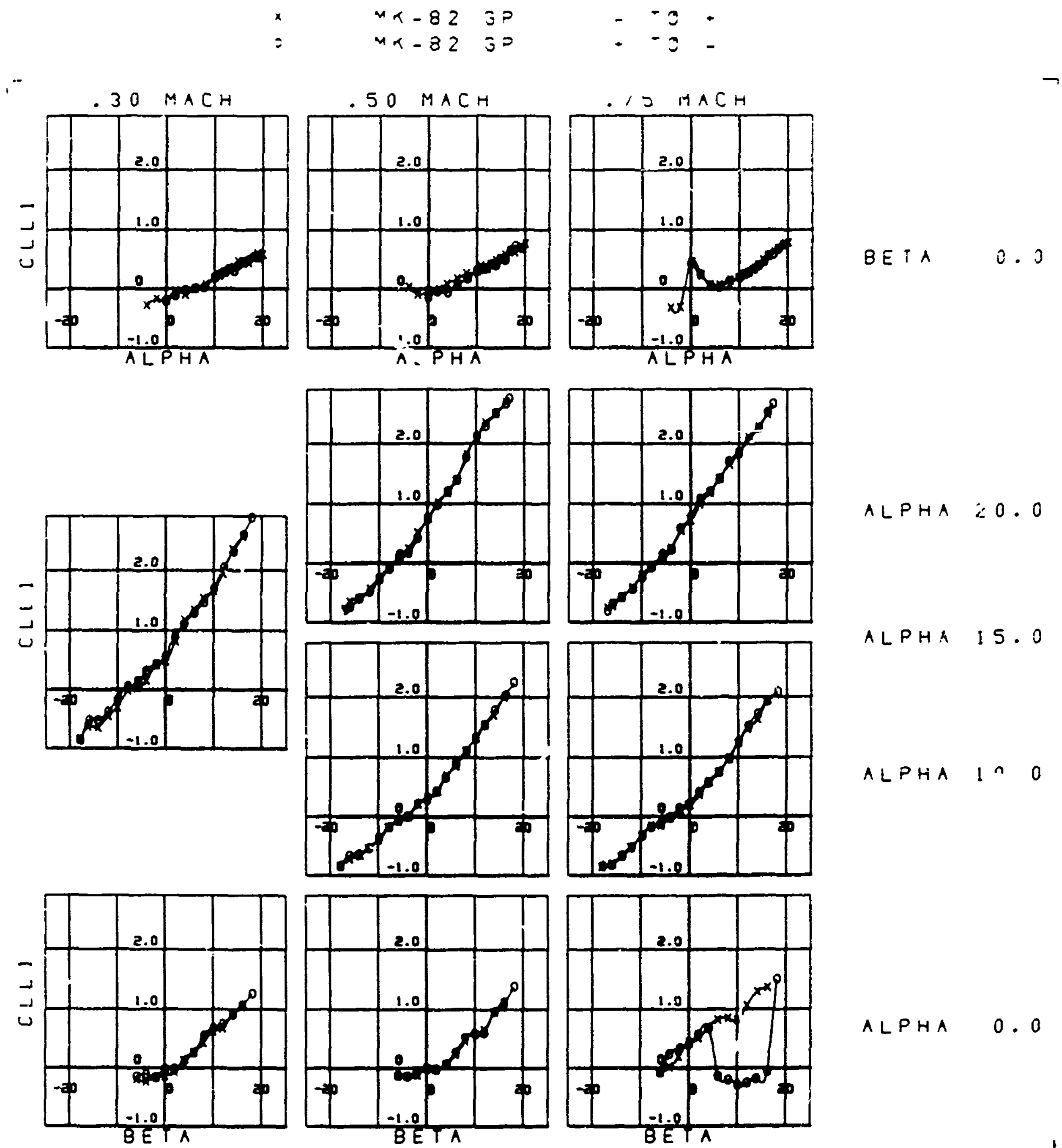


Figure 12. Hysteresis Data, CLL, Pylon 1, Configuration 30

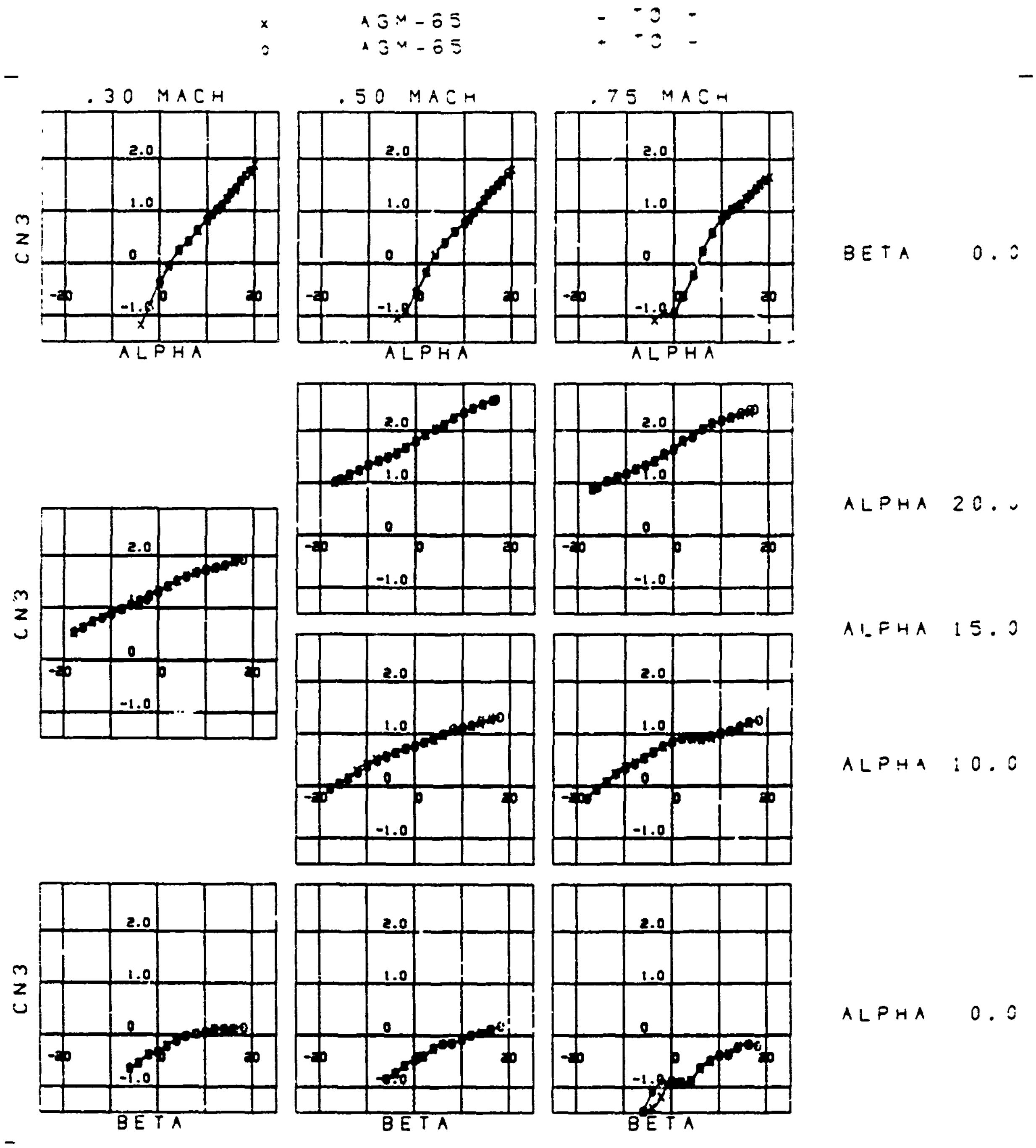


Figure 13. Hysteresis Data, CN, Pylon 3, Configuration 30

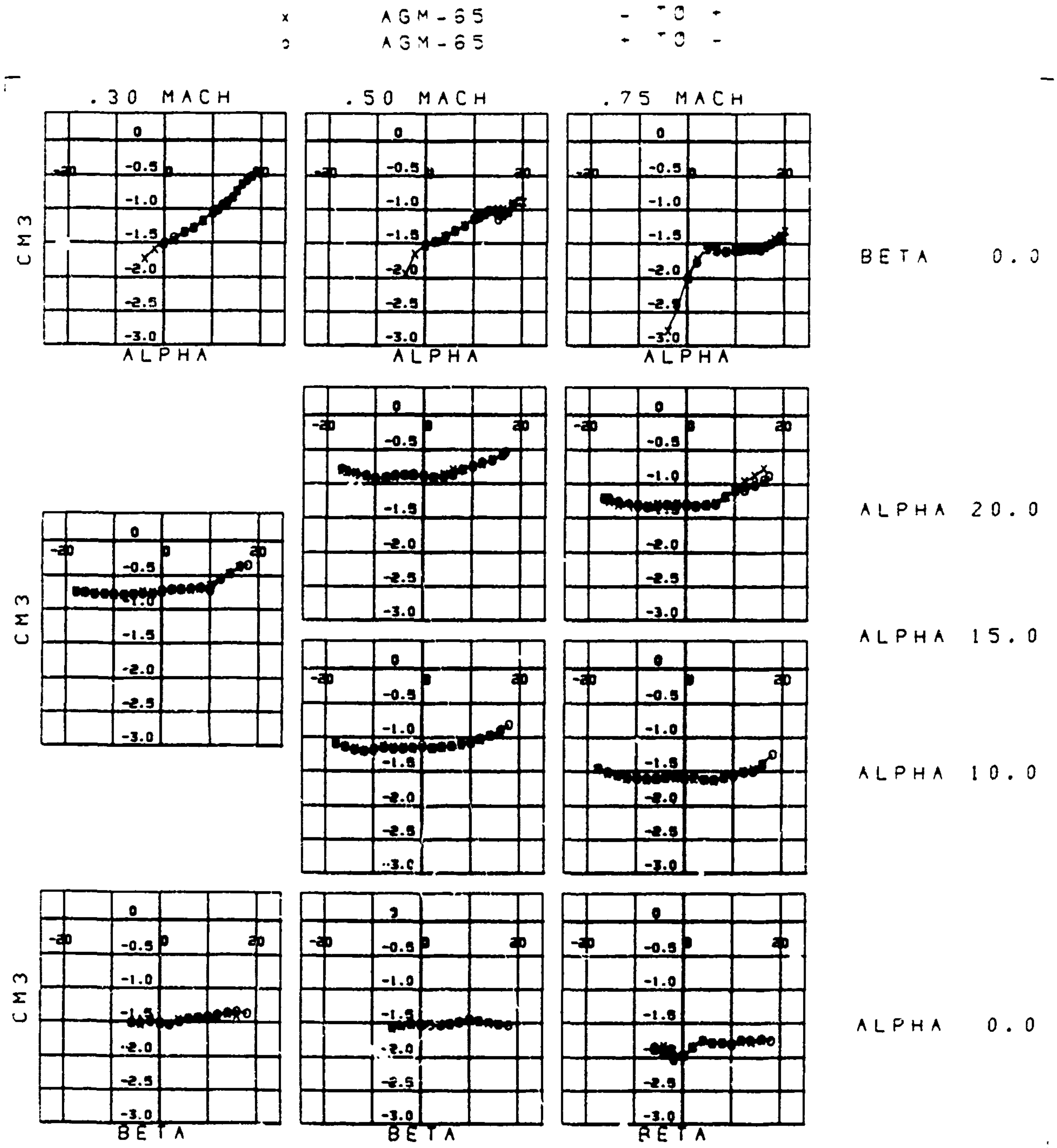


Figure 14. Hysteresis Data, CM, Pylon 3, Configuration 30

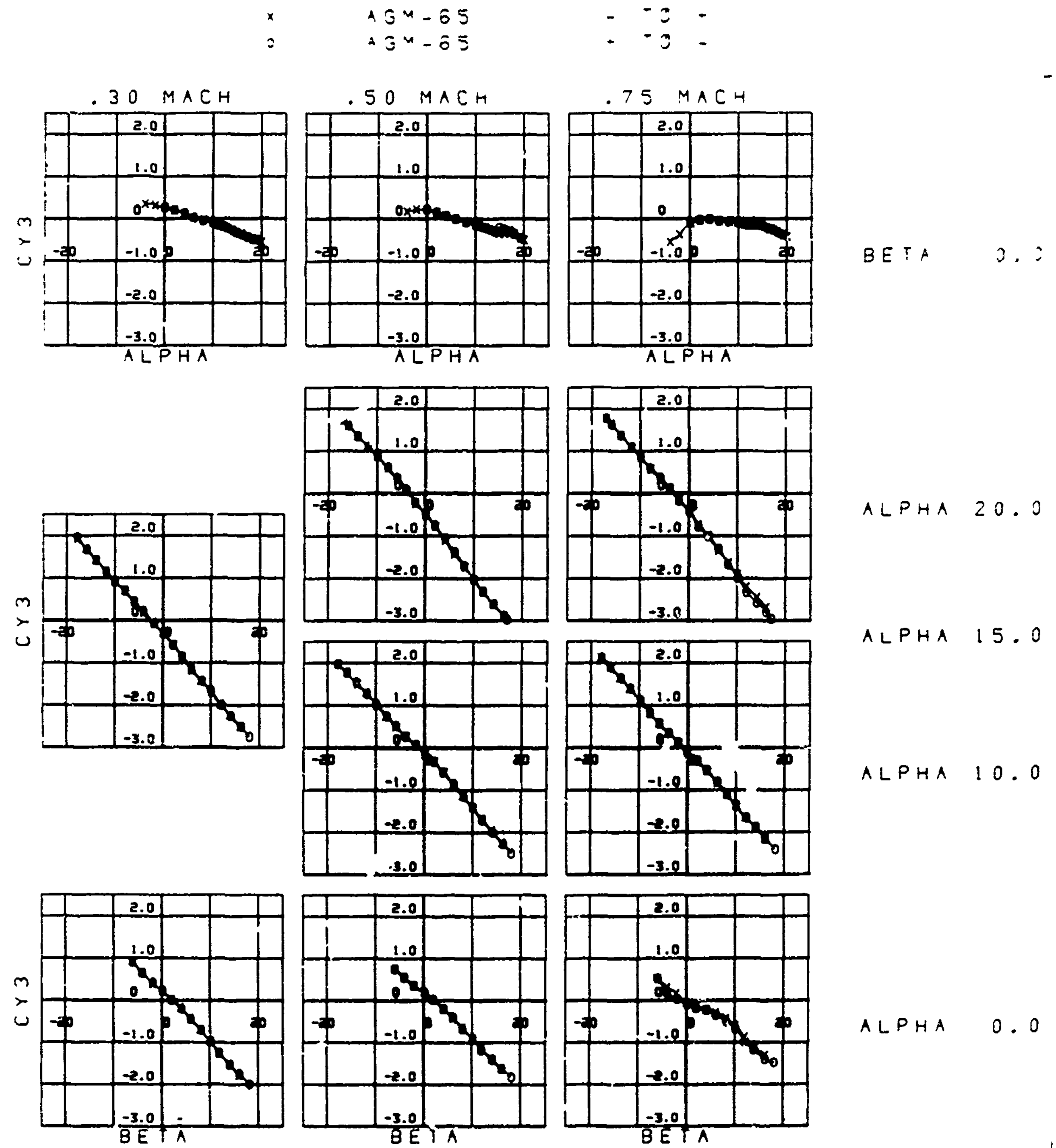


Figure 15. Hysteresis Data, CY, Pylon 3, Configuration 30

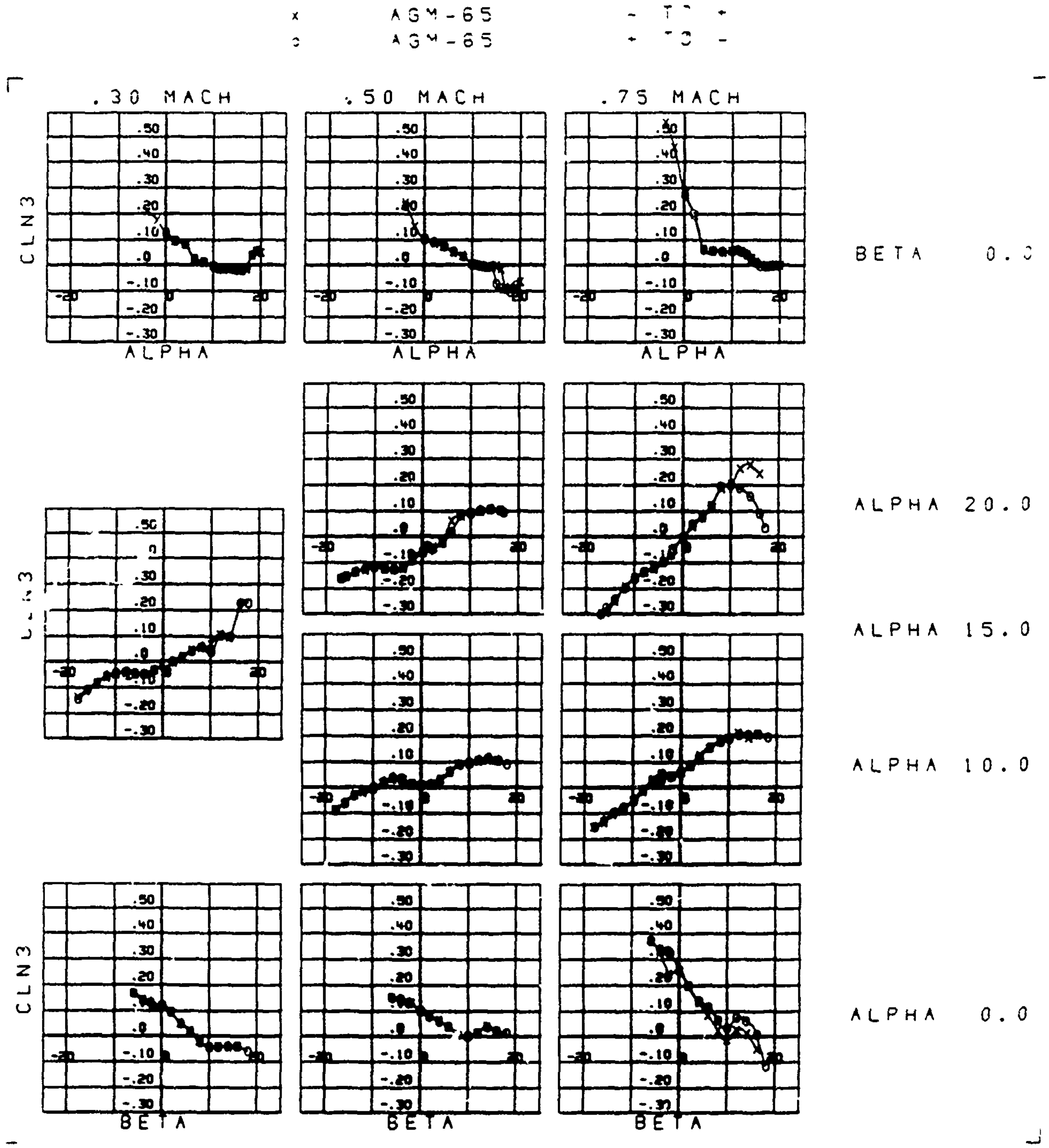


Figure 16. Hysteresis Data, CLN, Pylon 3, Configuration 30

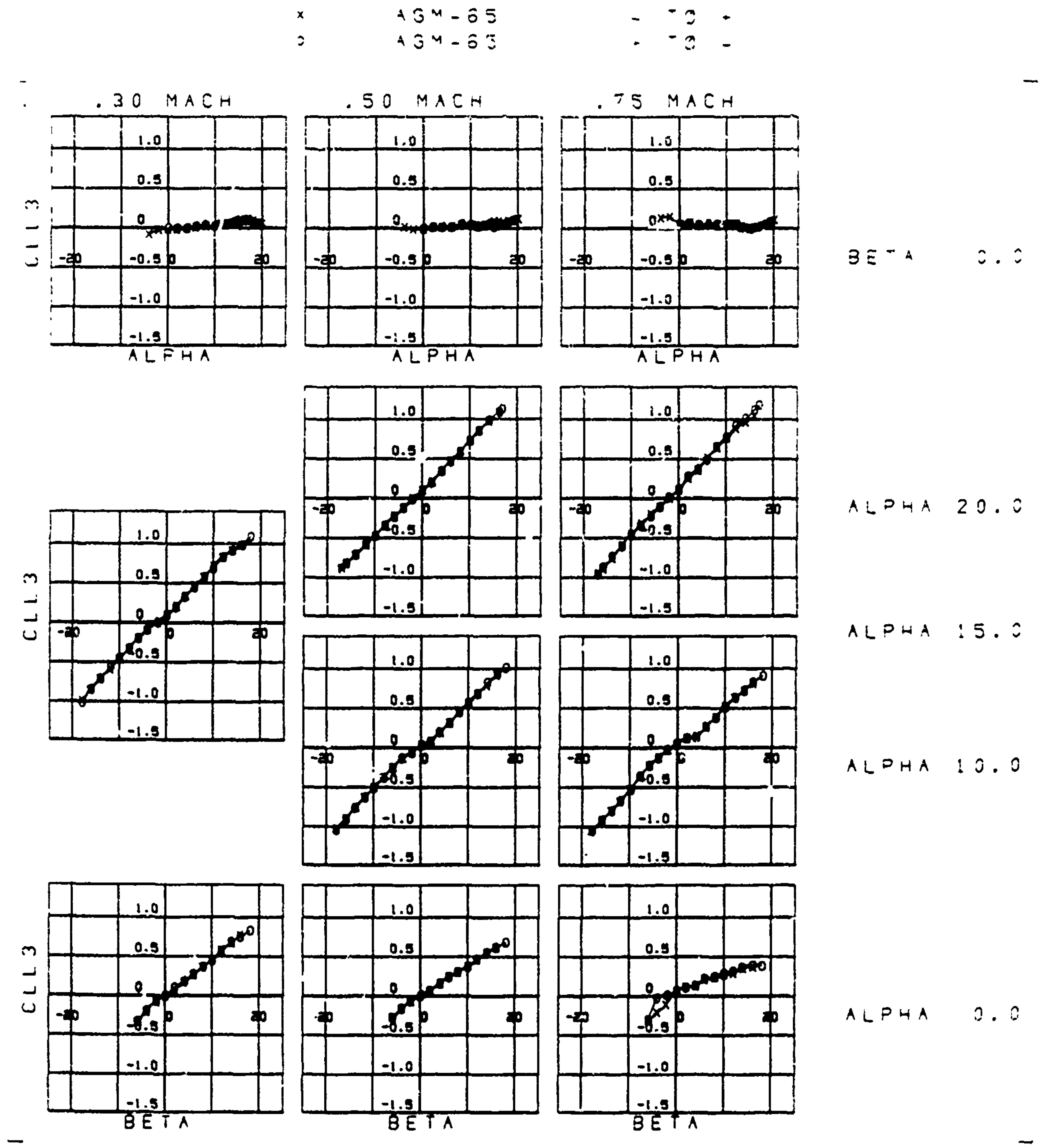


Figure 17. Hysteresis Data, CLL, Pylon 3, Configuration 30

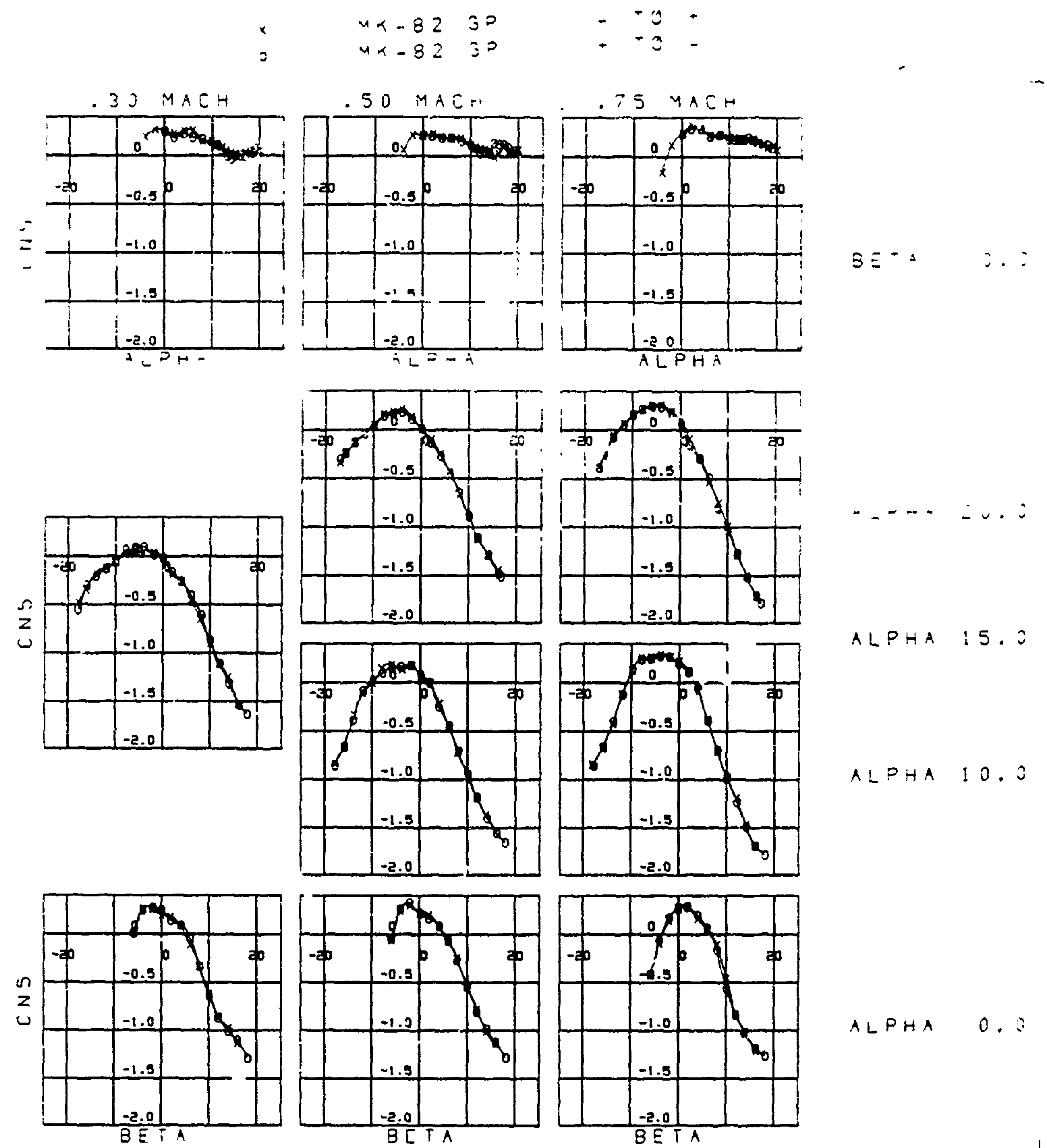


Figure 18. Hysteresis Data, CN, Pylon 5, Configuration 30

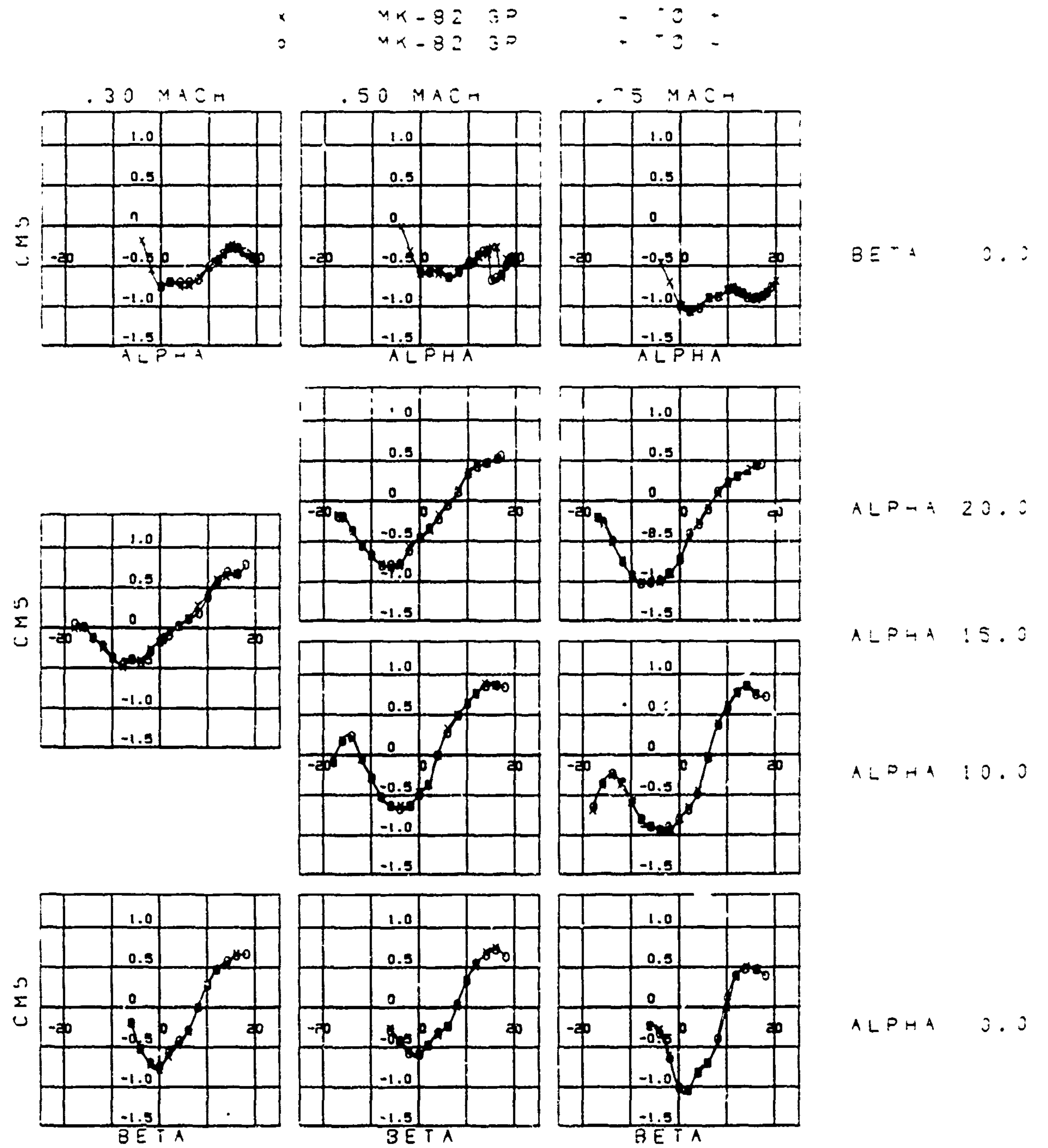


Figure 19. Hysteresis Data, CM, Pylon 5, Configuration 30

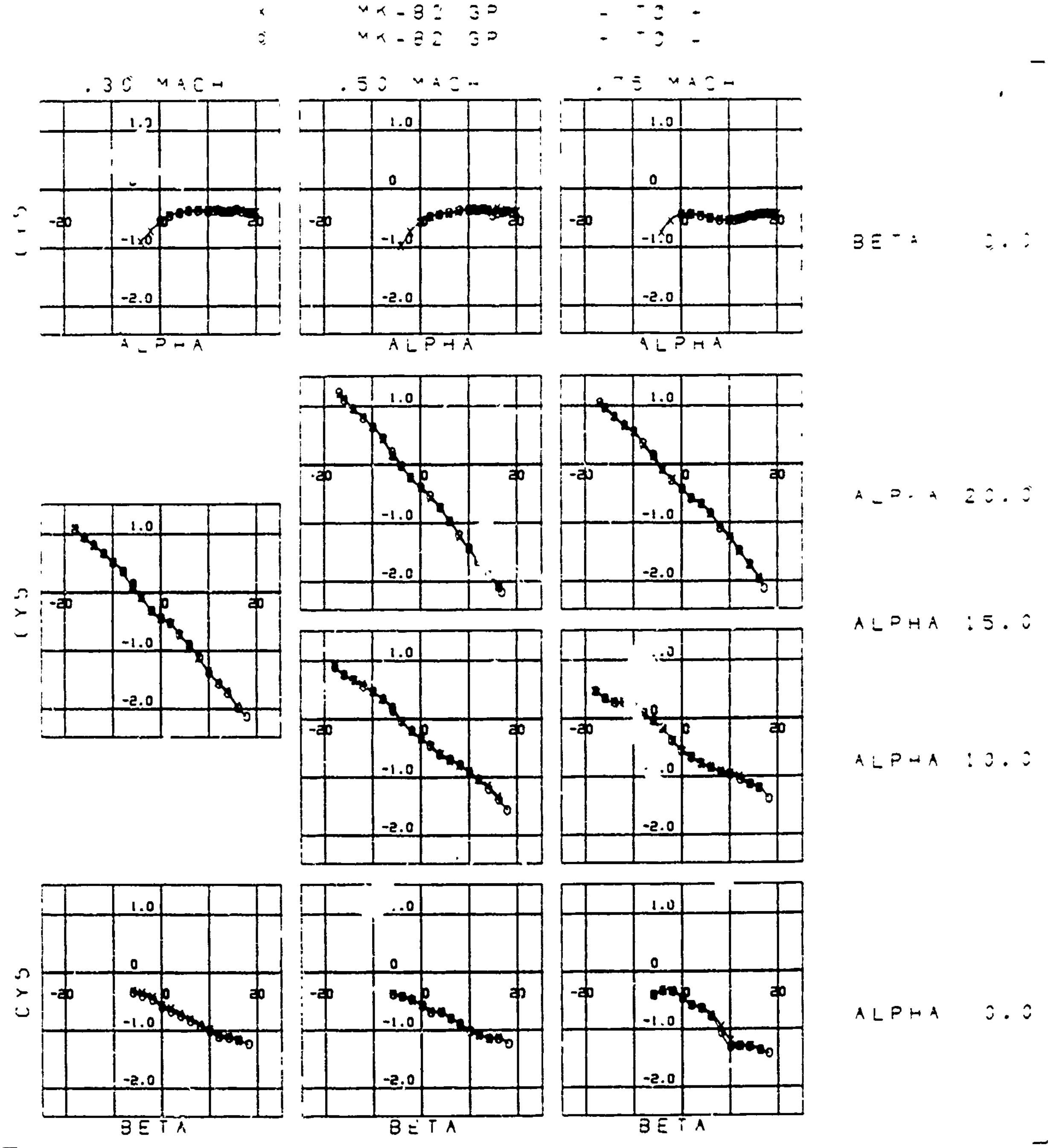


Figure 20. Hysteresis Data, CY, Pylon 5, Configuration 30

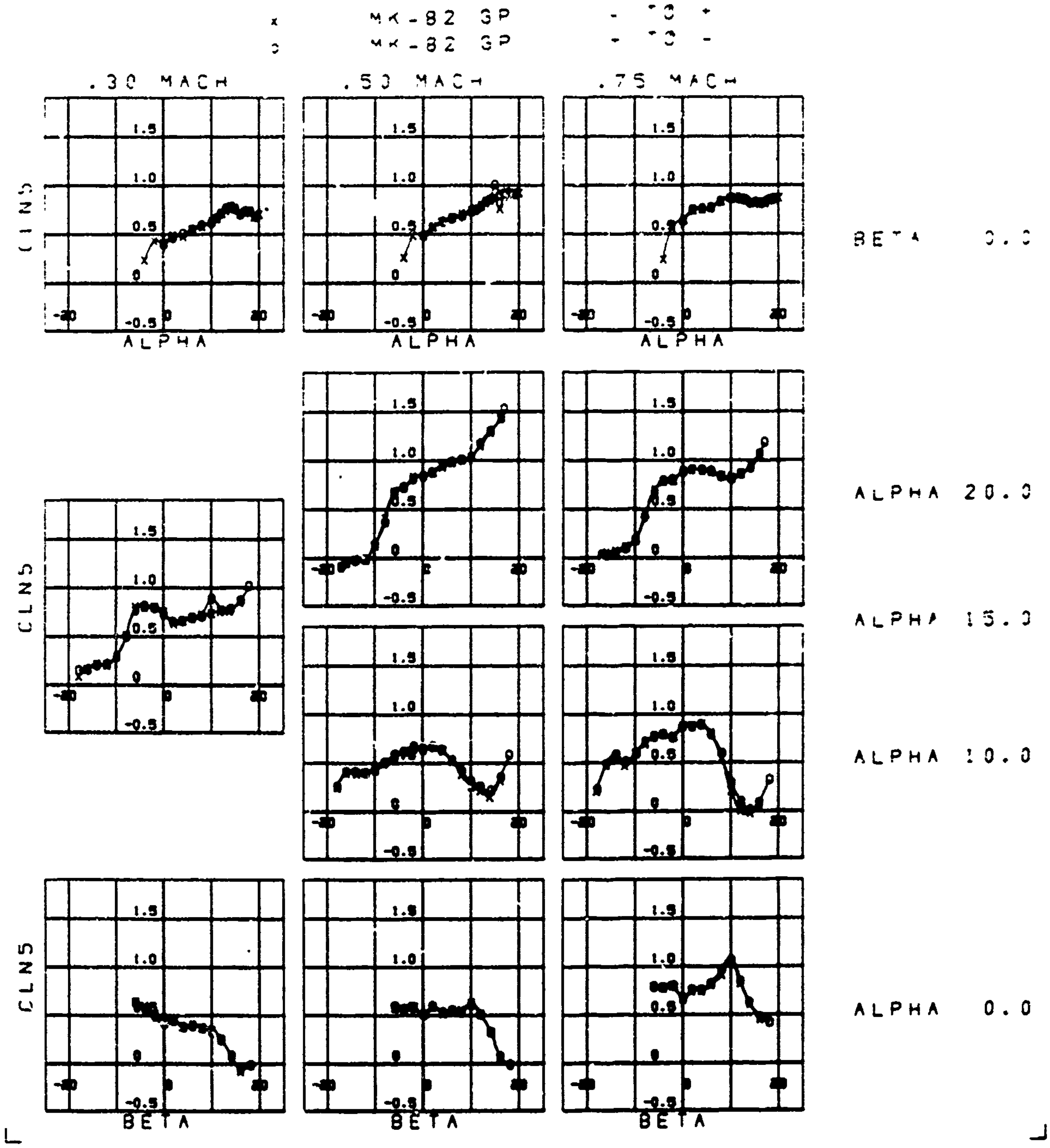


Figure 21. Hysteresis Data, CLN, Pylon 5, Configuration 30

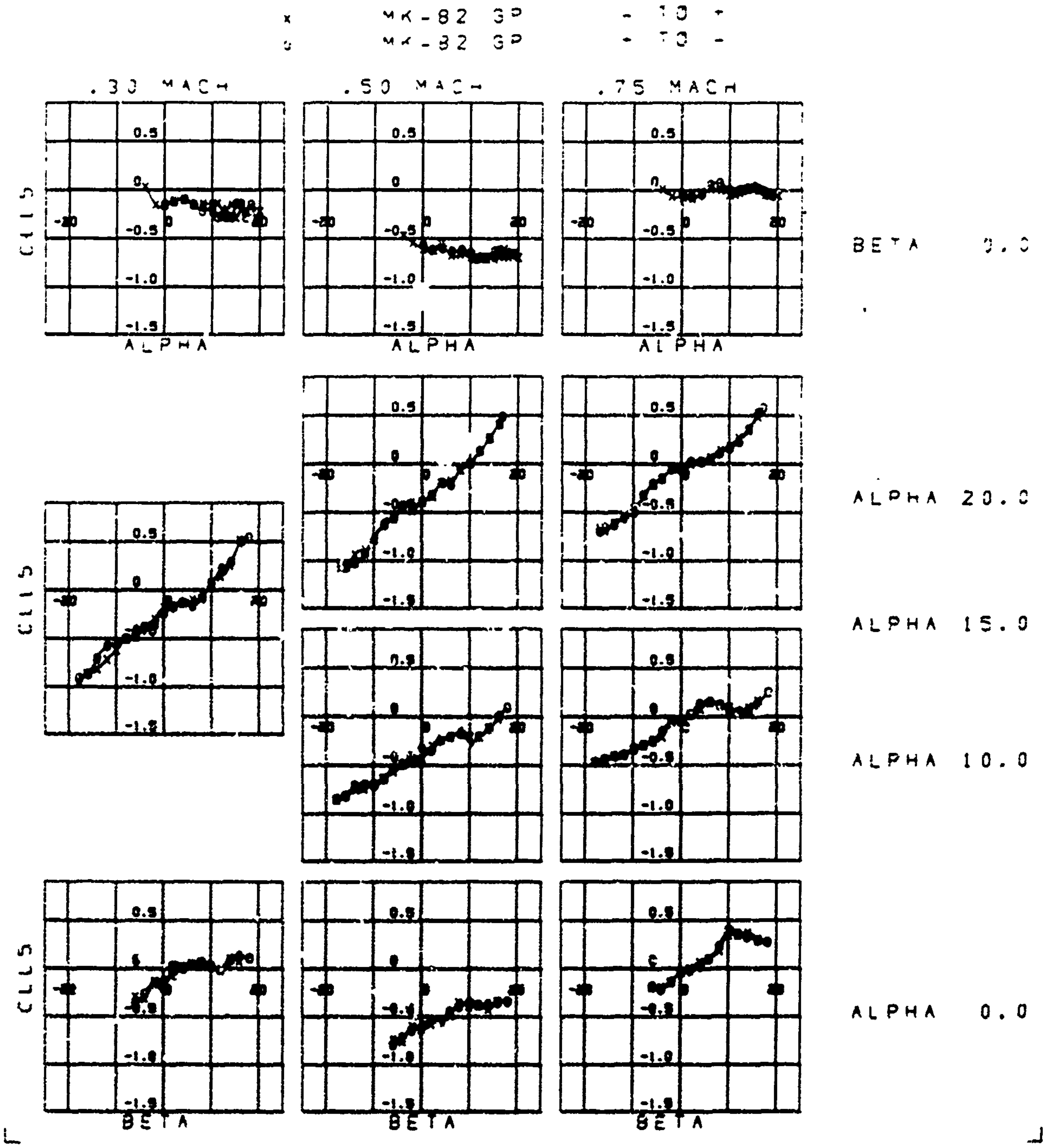


Figure 22. Hysteresis Data, CLL, Pylon 5, Configuration 30

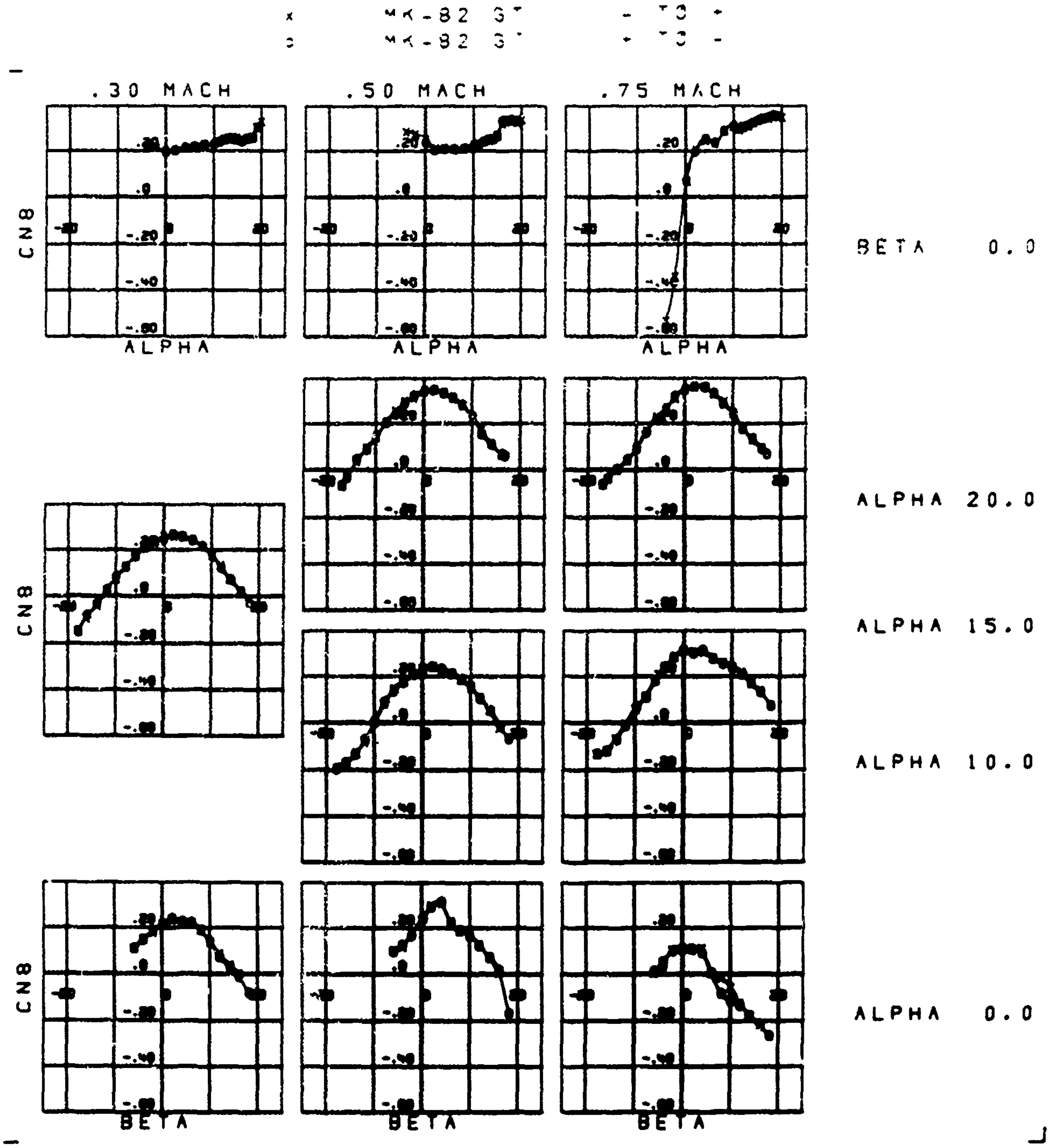


Figure 23. Hysteresis Data, CN, Pylon 8, Configuration 30

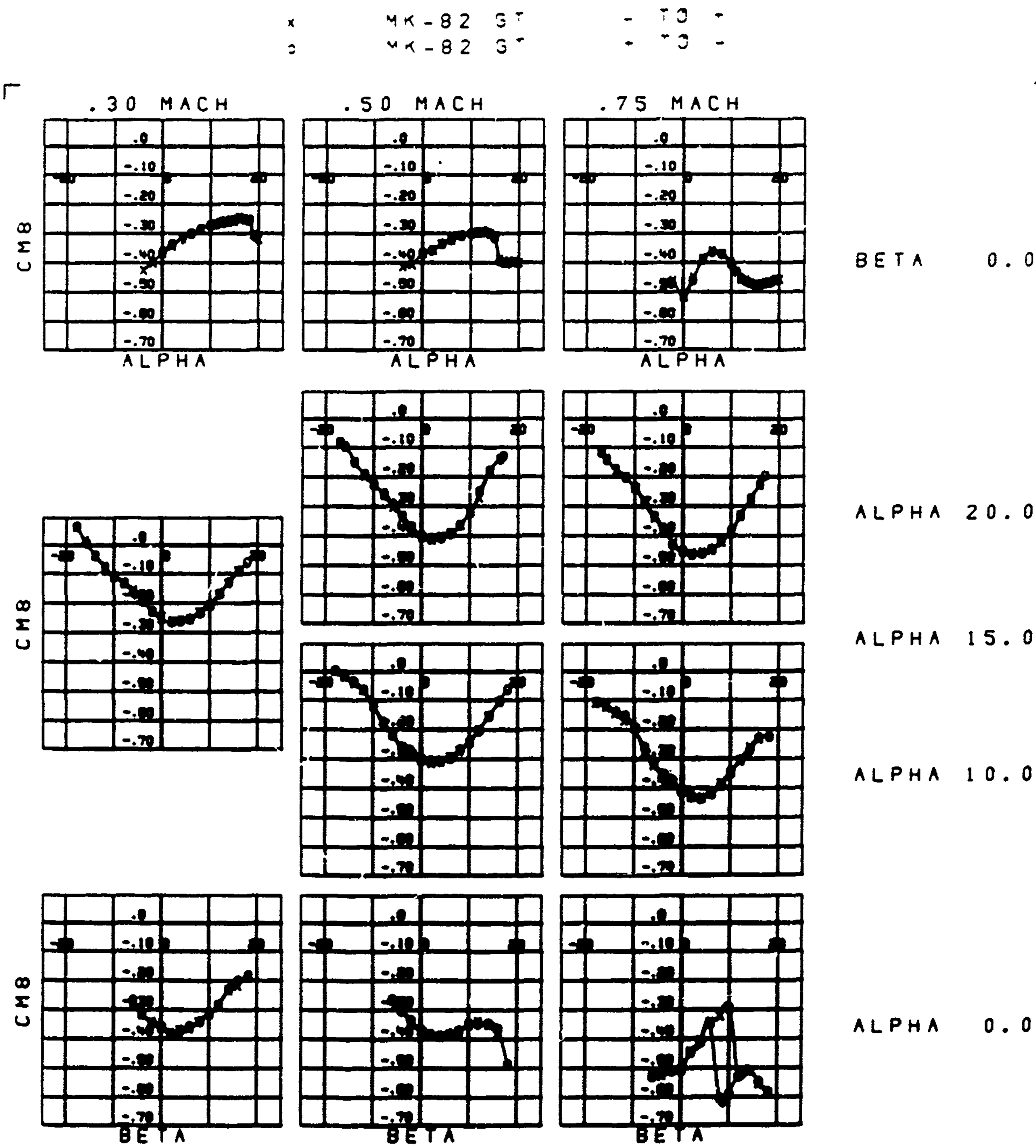


Figure 24. Hysteresis Data, CM, Pylon 8, Configuration 30

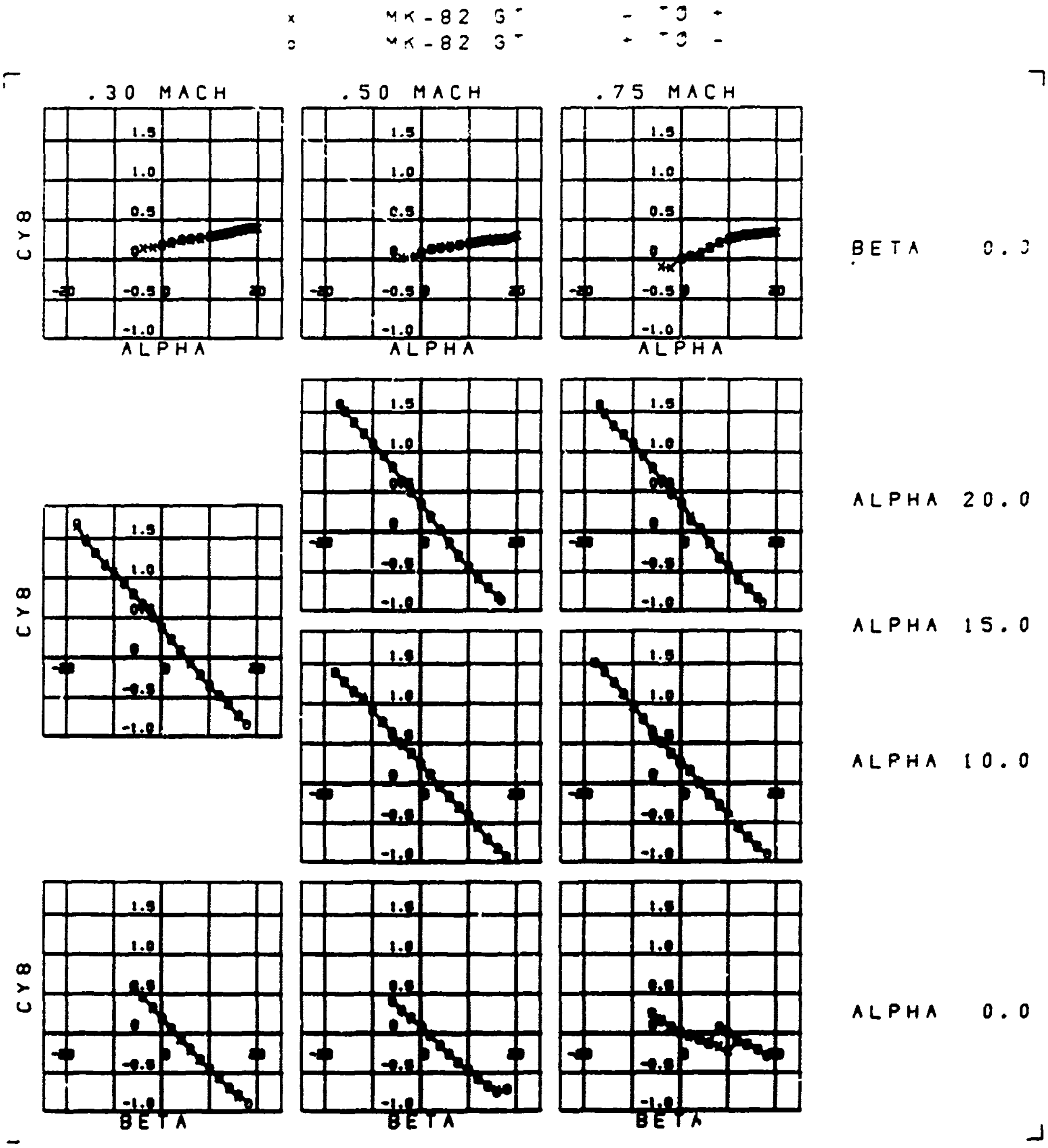


Figure 25. Hysteresis Data, CY, Pylon 8, Configuration 30

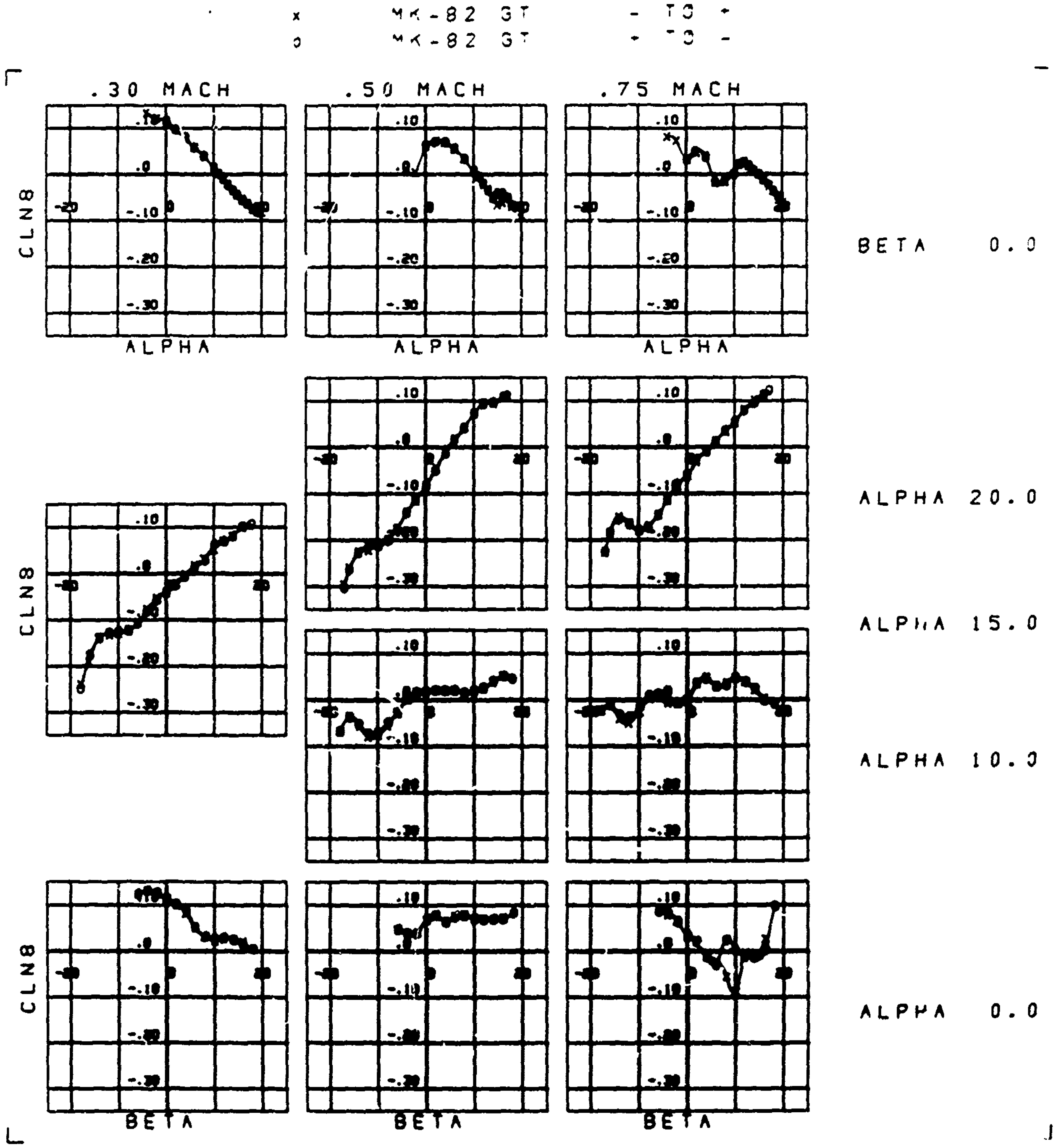


Figure 26. Hysteresis Data, CLN, Pylon 8, Configuration 30

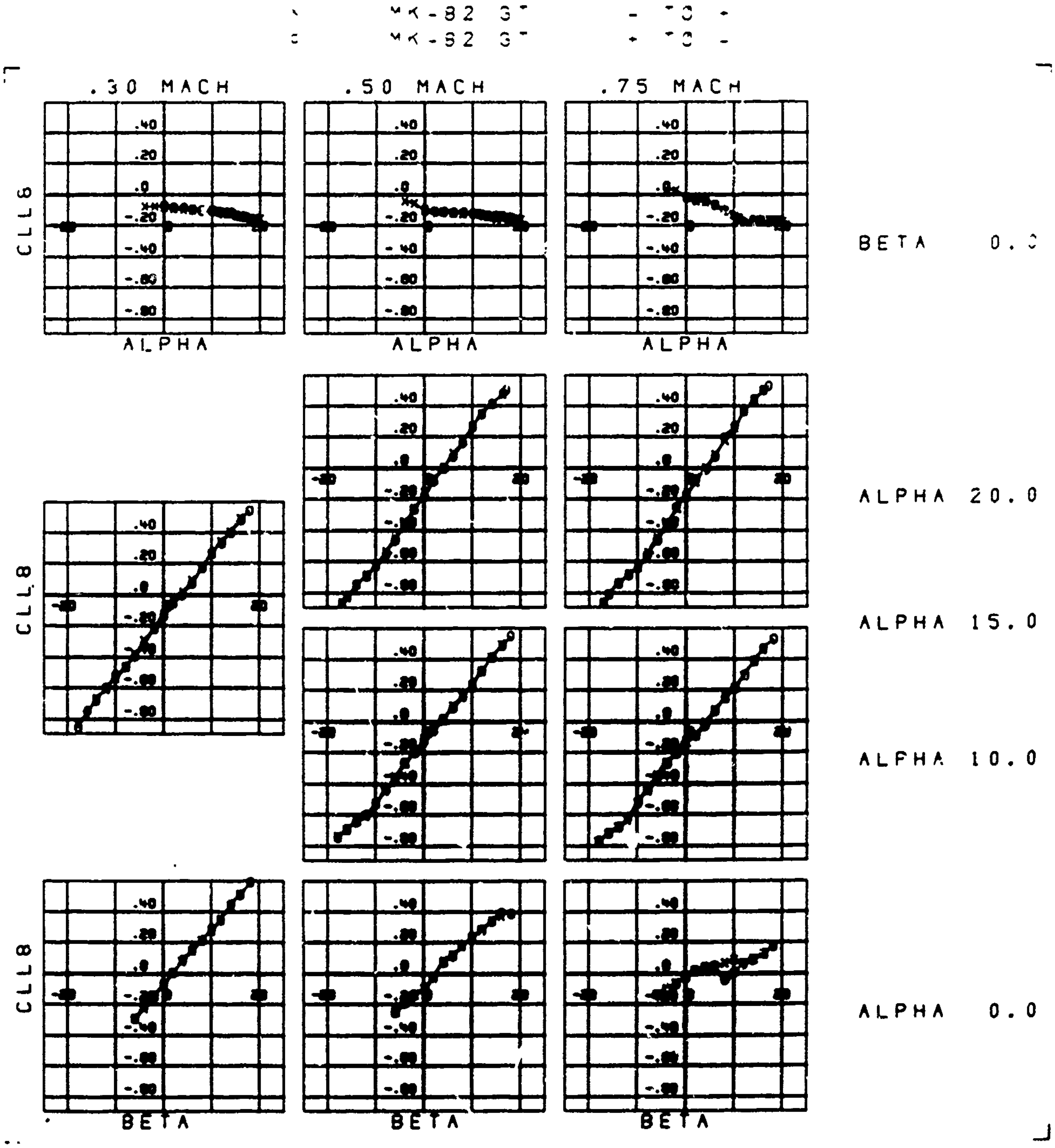


Figure 27. Hysteresis Data, CLL, Pylon 8, Configuration 30

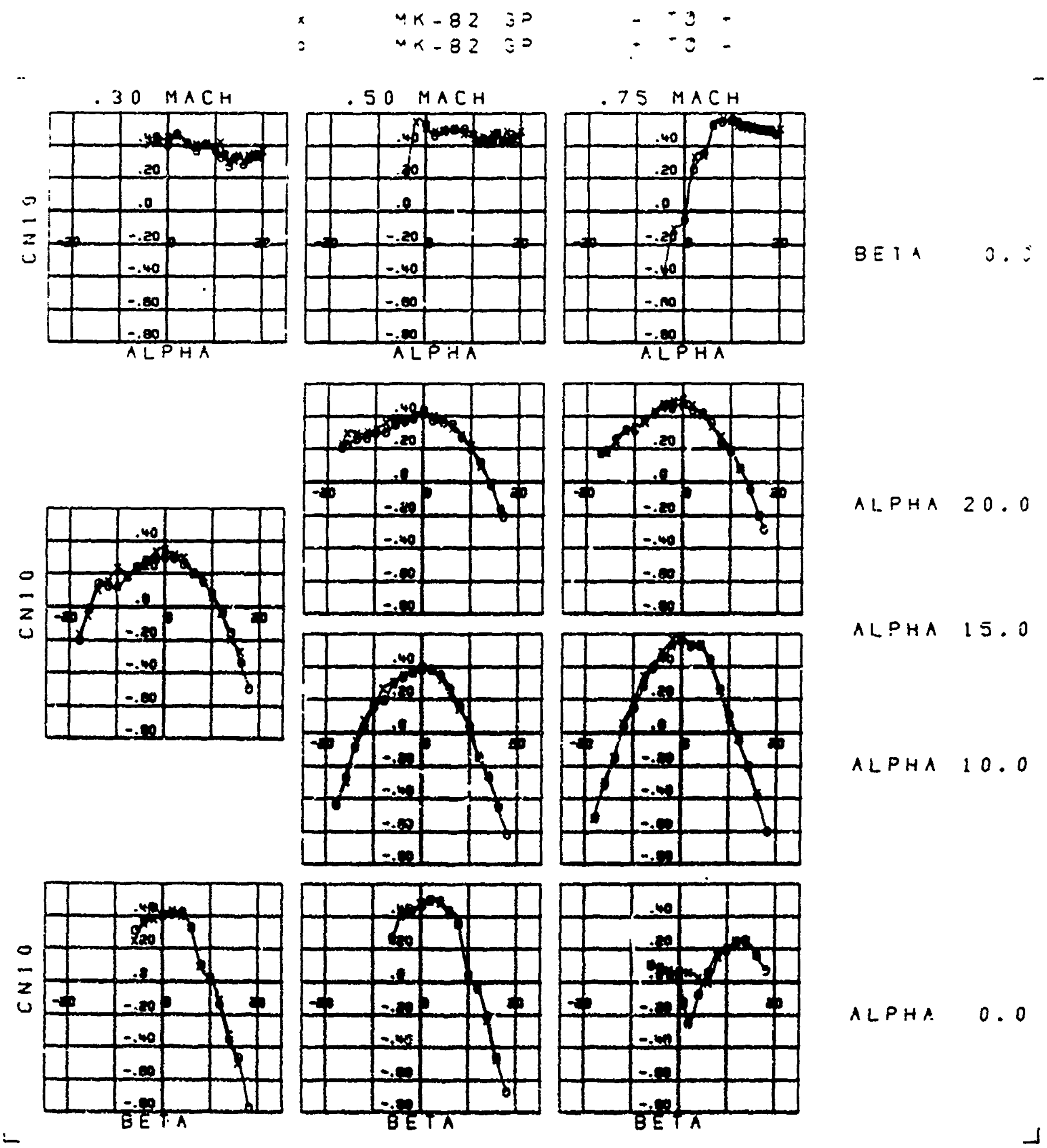


Figure 28. Hysteresis Data, CN, Pylon 10, Configuration 30

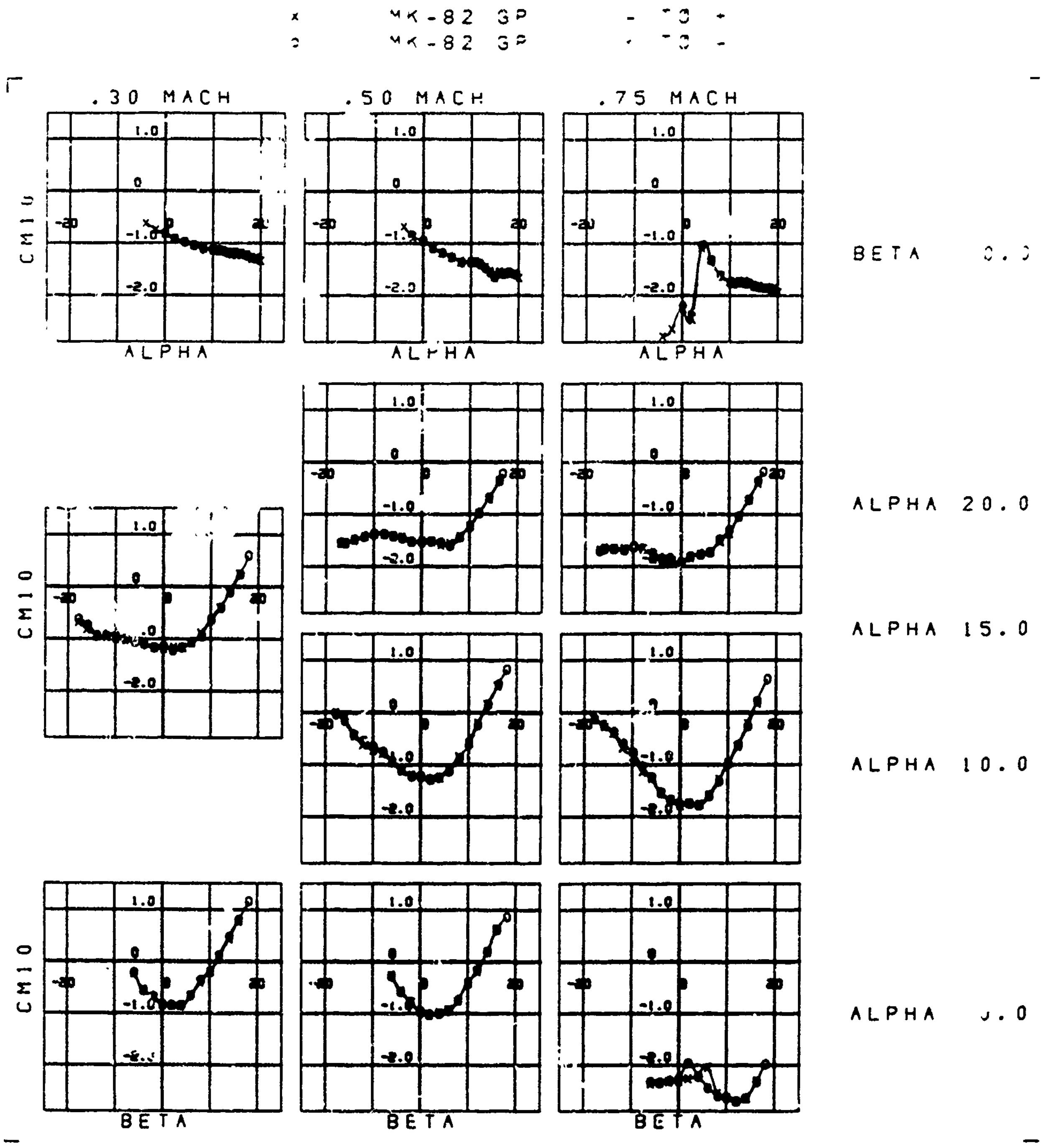


Figure 29. Hysteresis Data, CM, Pylon 10, Configuration 30

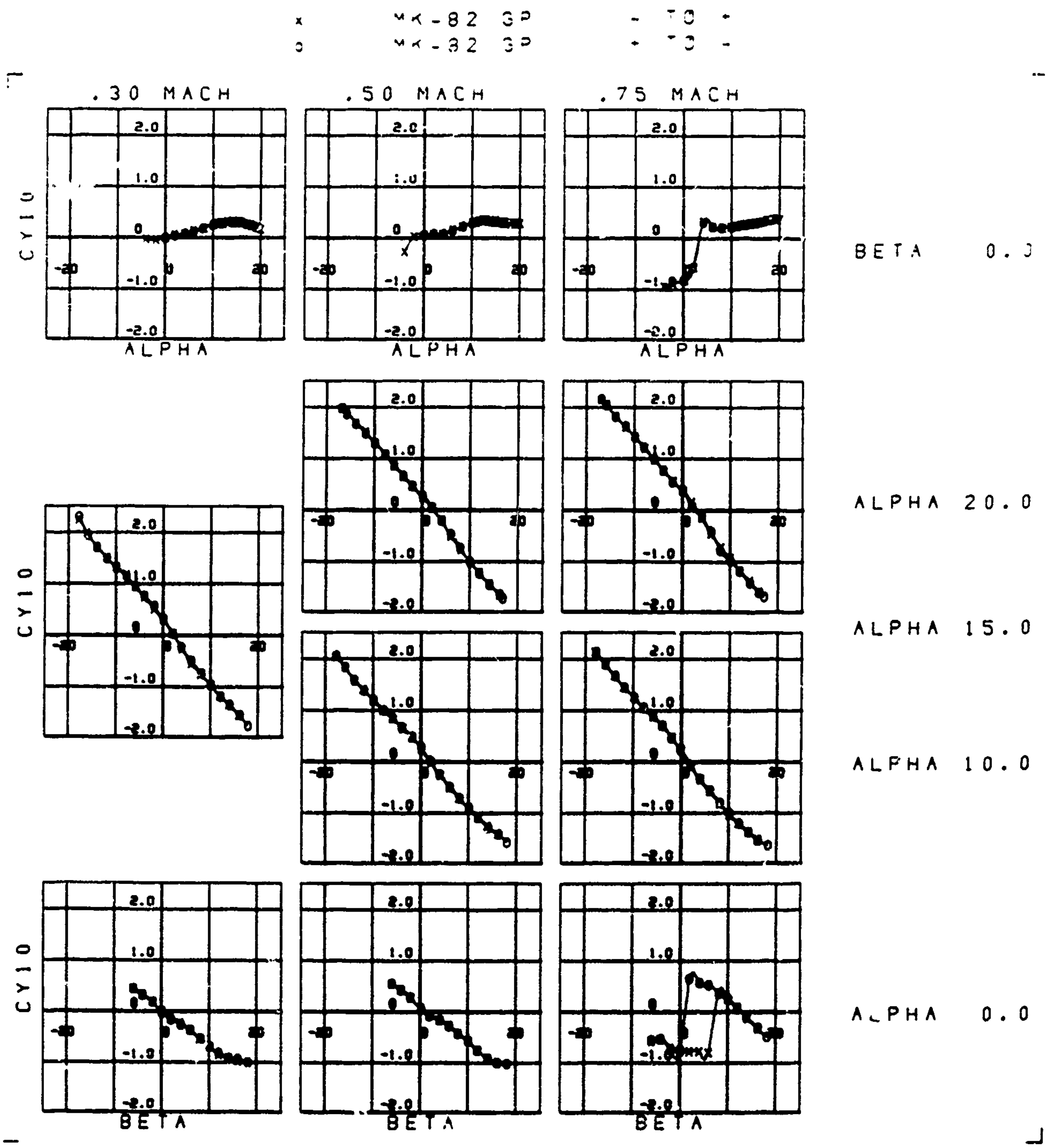


Figure 30. Hysteresis Data, CY, Pylon 10, Configuration 30

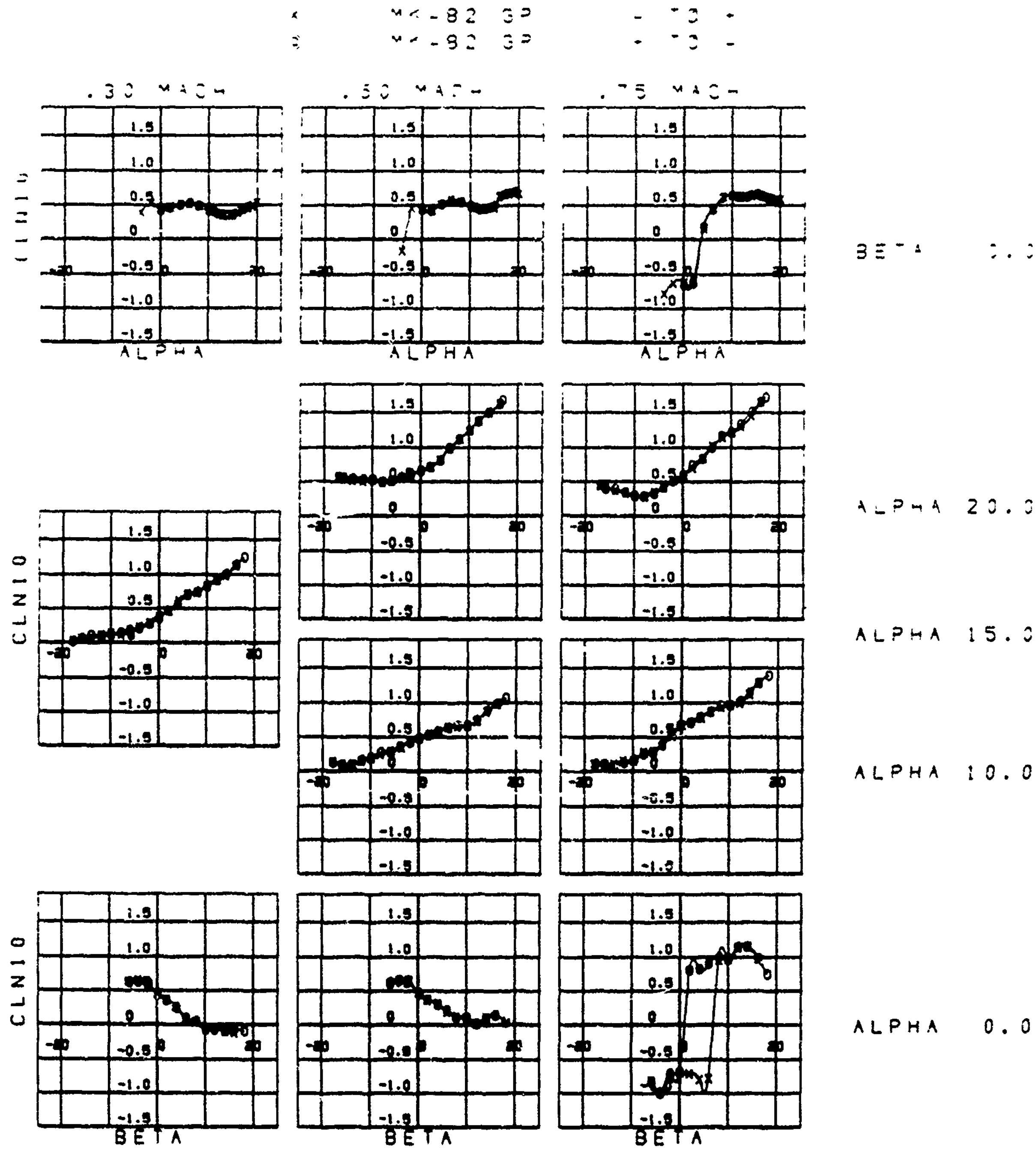


Figure 31. Hysteresis Data, CLN, Pylon 10, Configuration 30

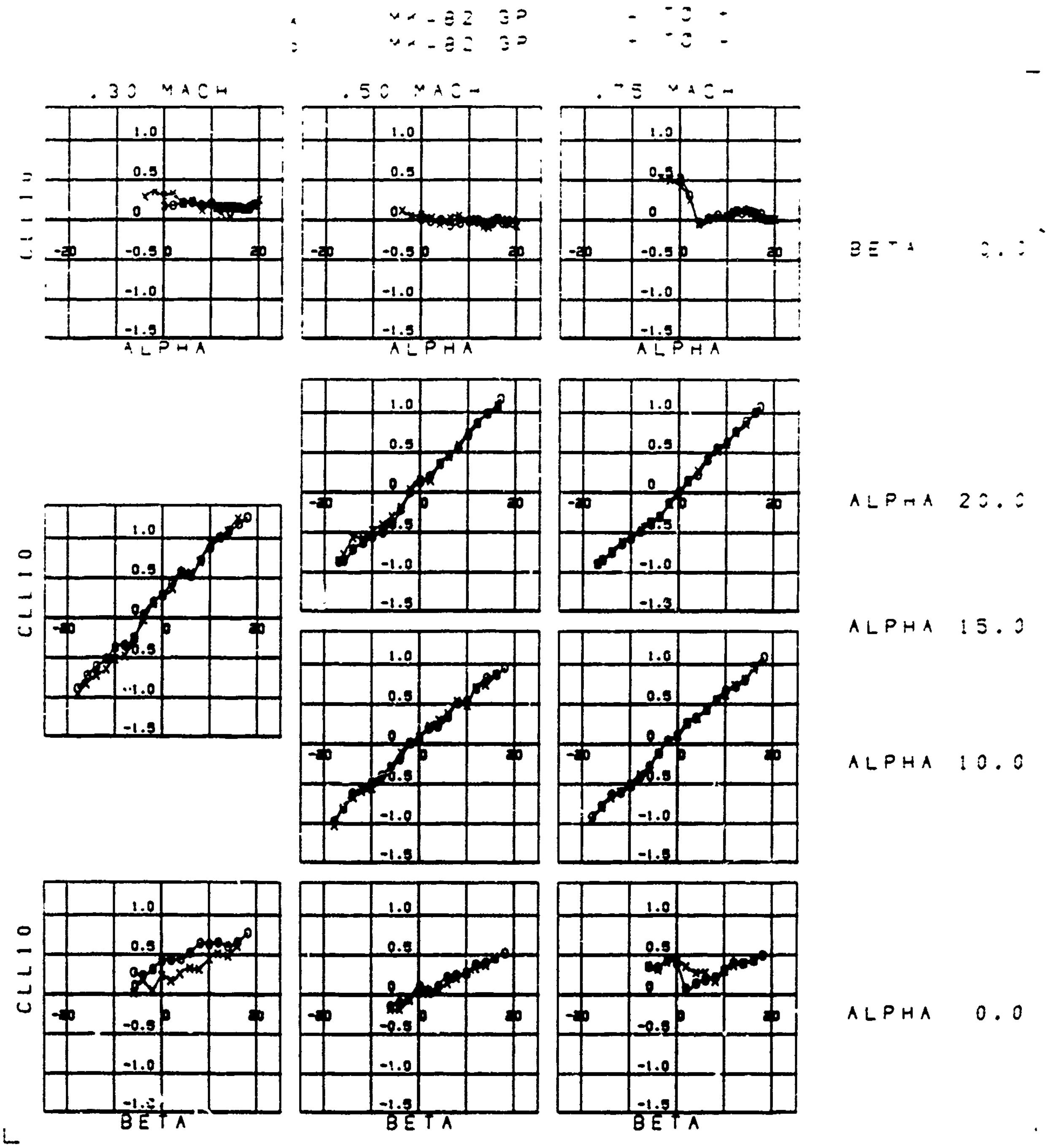


Figure 32. Hysteresis Data, CLL, Pylon 10, Configuration 30

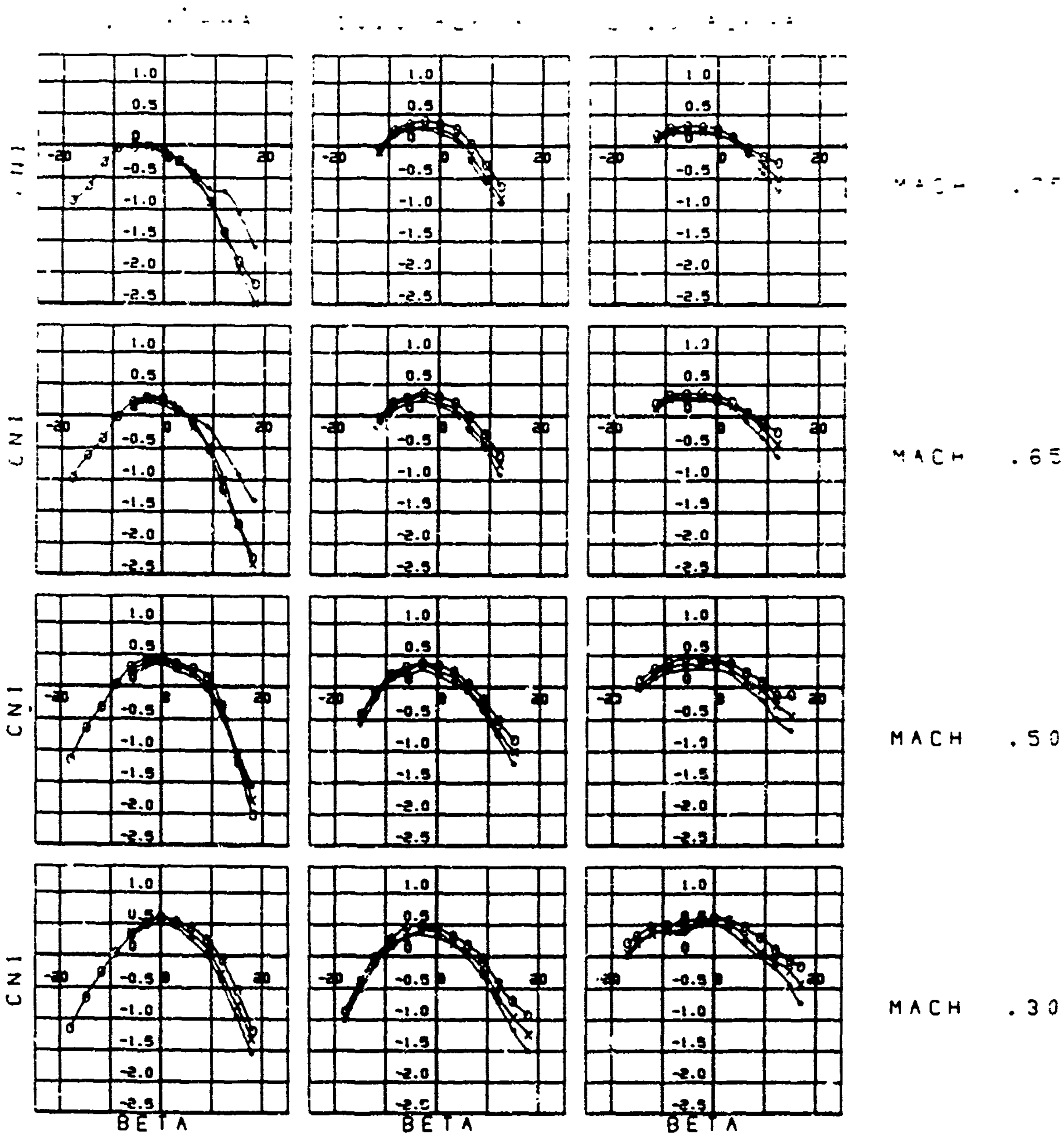


Figure 33. CN, Pylon 1 Versus Pylon 2, Cases 1, 5, 6

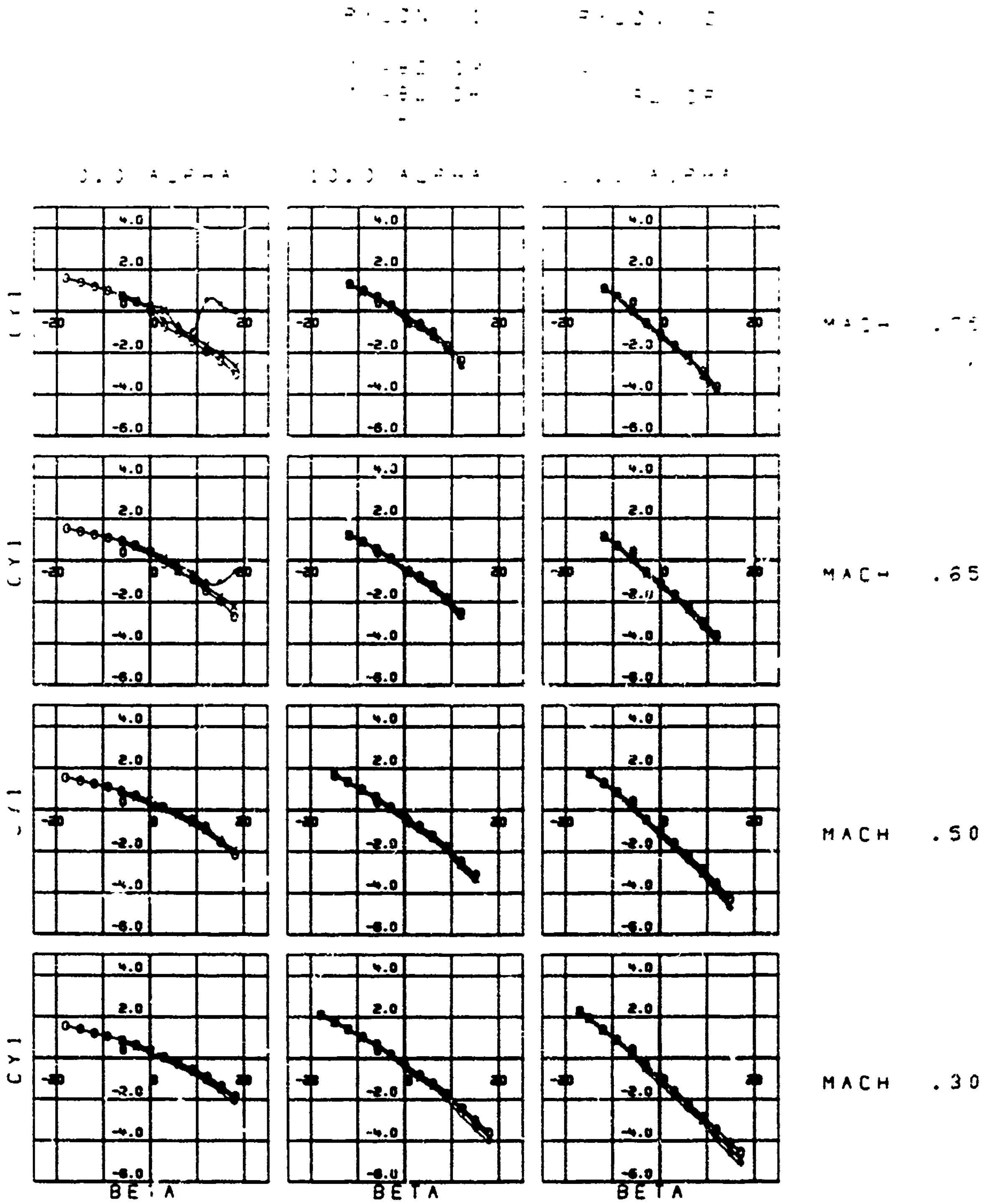


Figure 34. CY, Pylon 1 Versus Pylon 2, Cases 1, 5, 6

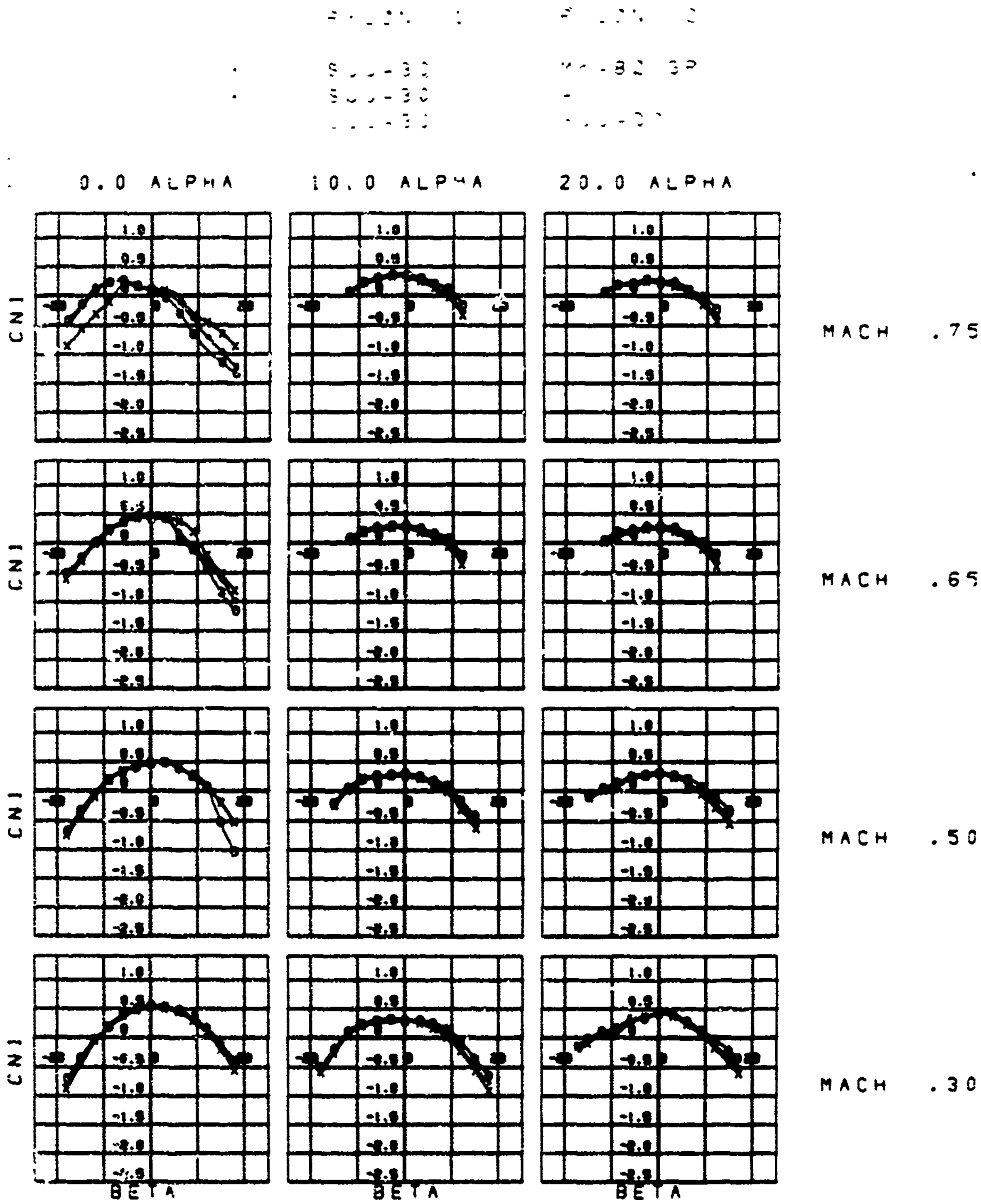


Figure 35. CN, Pylon 1 Versus Pylon 2, Cases 2, 7, 8

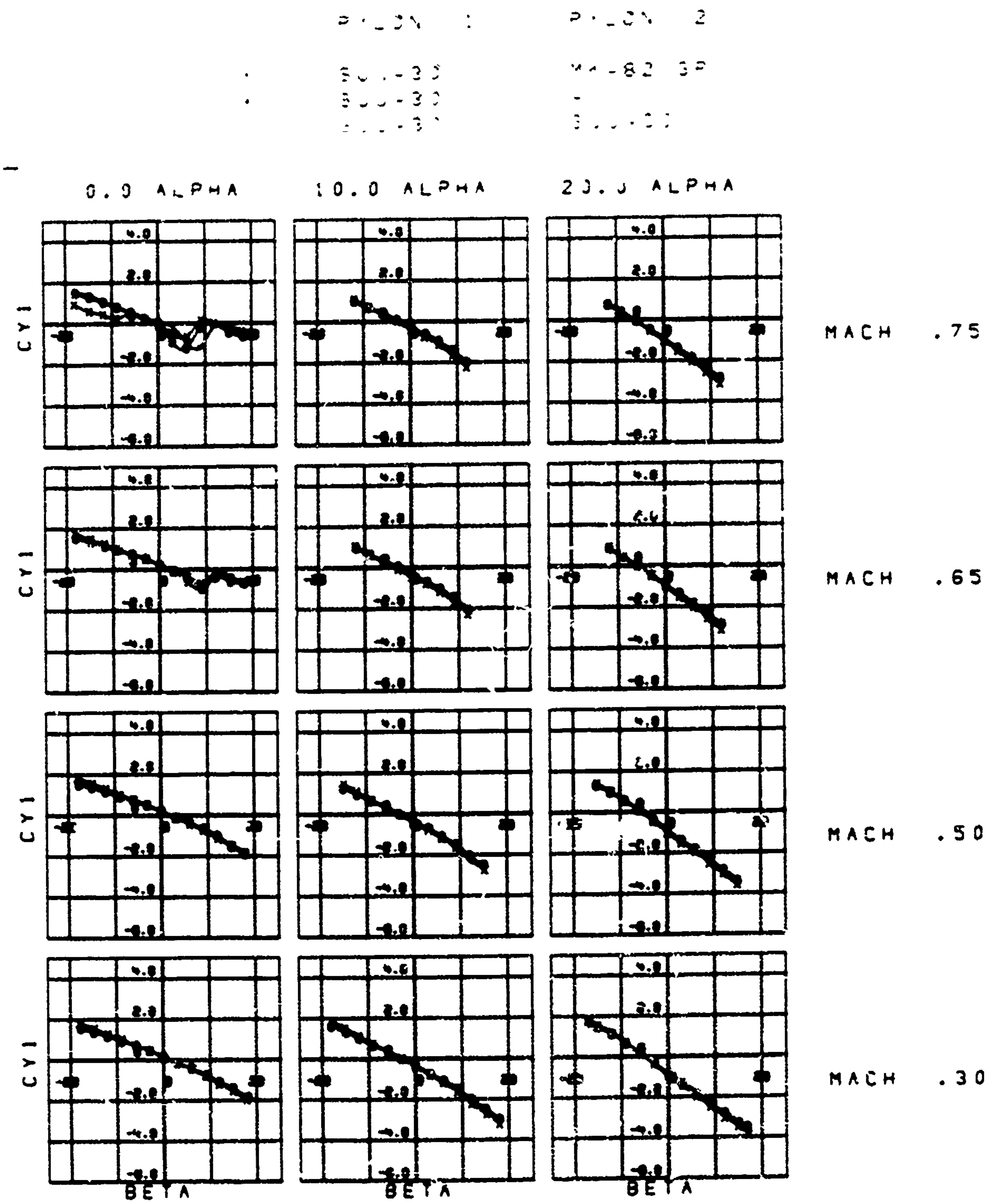


Figure 36. CY, Pylon 1 Versus Pylon 2, Cases 2, 7, 8

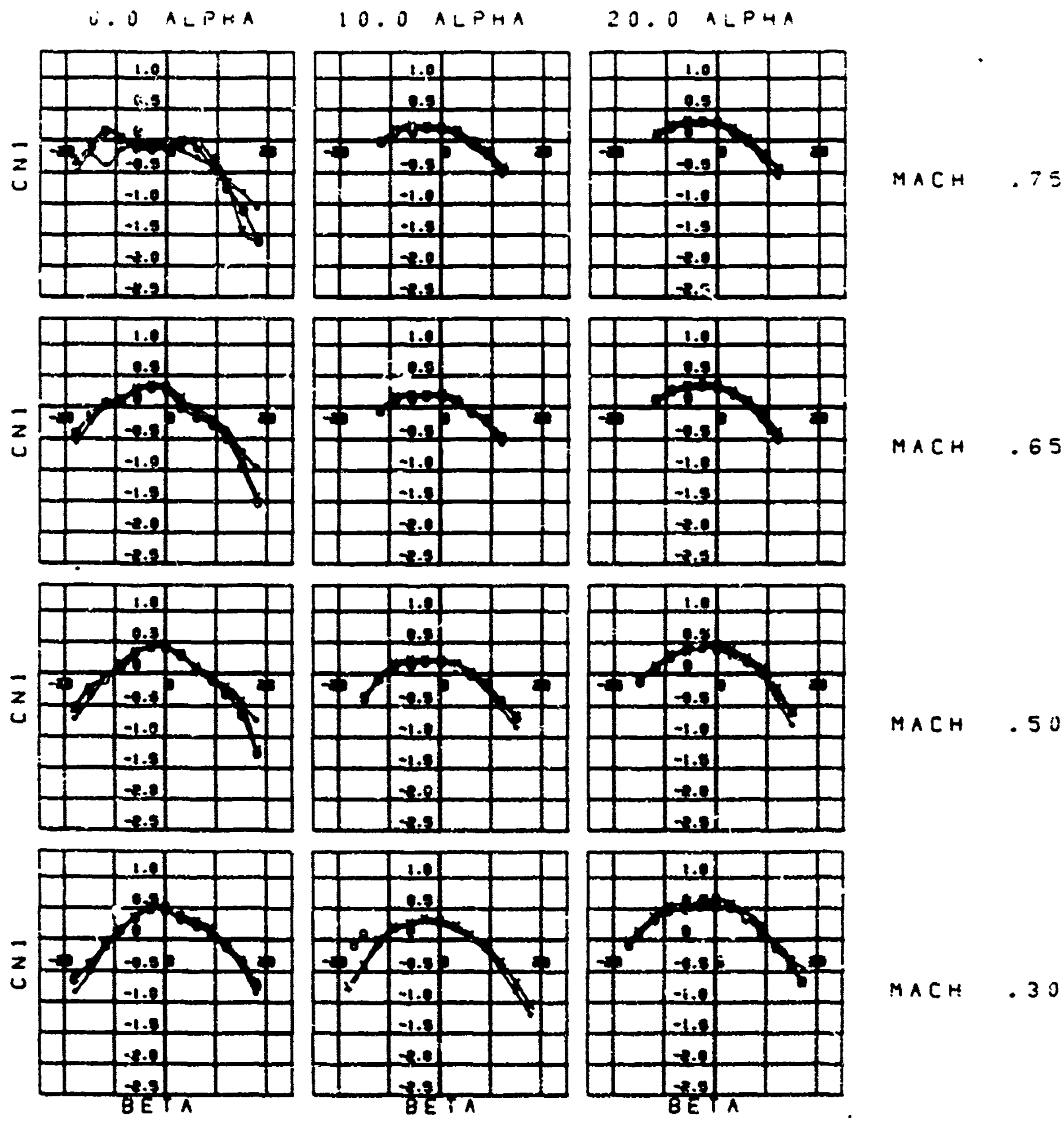


Figure 37. CN, Pylon 1 Versus Pylon 2, Cases 3, 9, 10

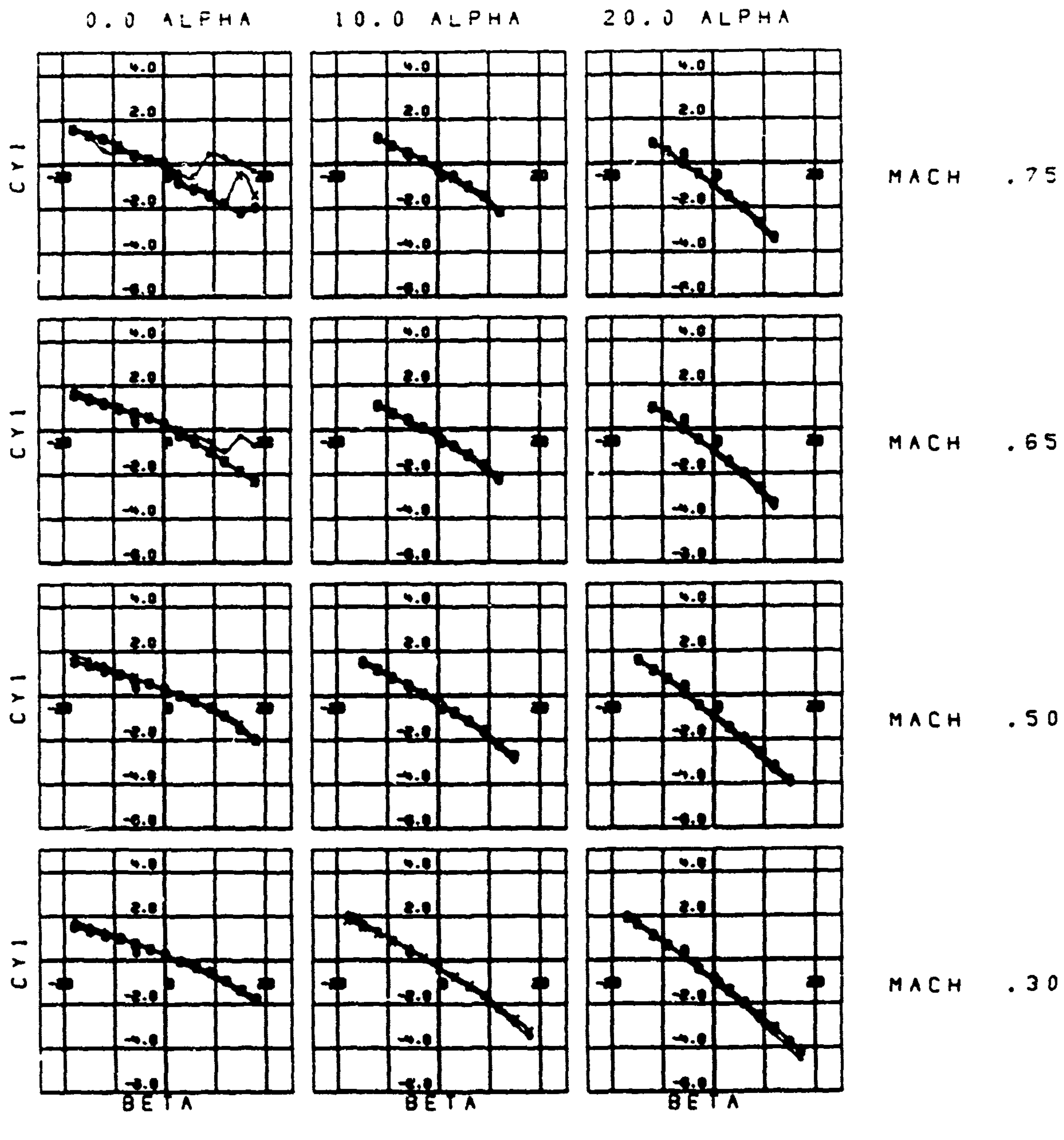


Figure 38. CY, Pylon 1 Versus Pylon 2, Cases 3, 9, 10

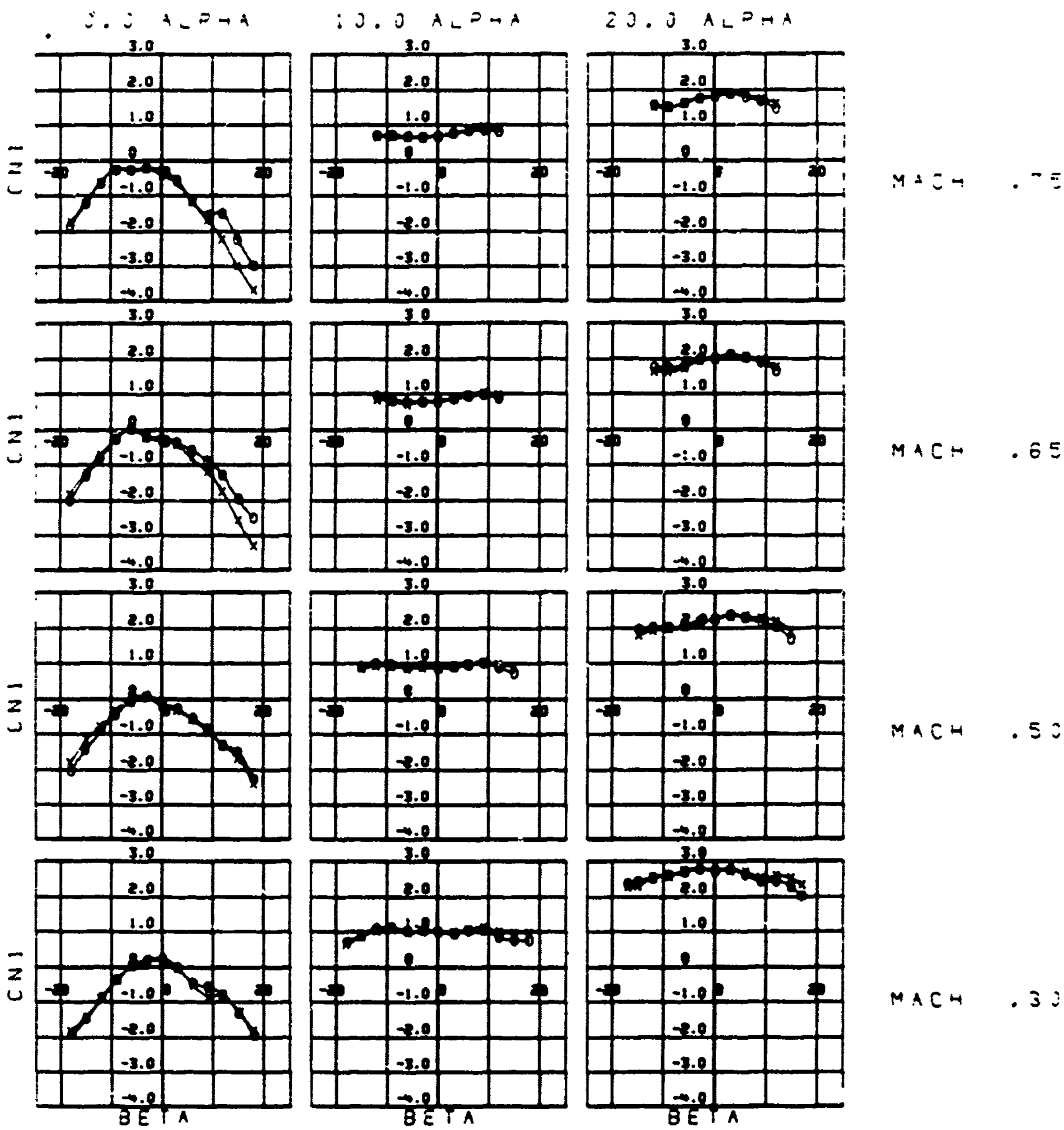


Figure 39. CN, Pylon 1 Versus Pylon 2, Cases 4, 11

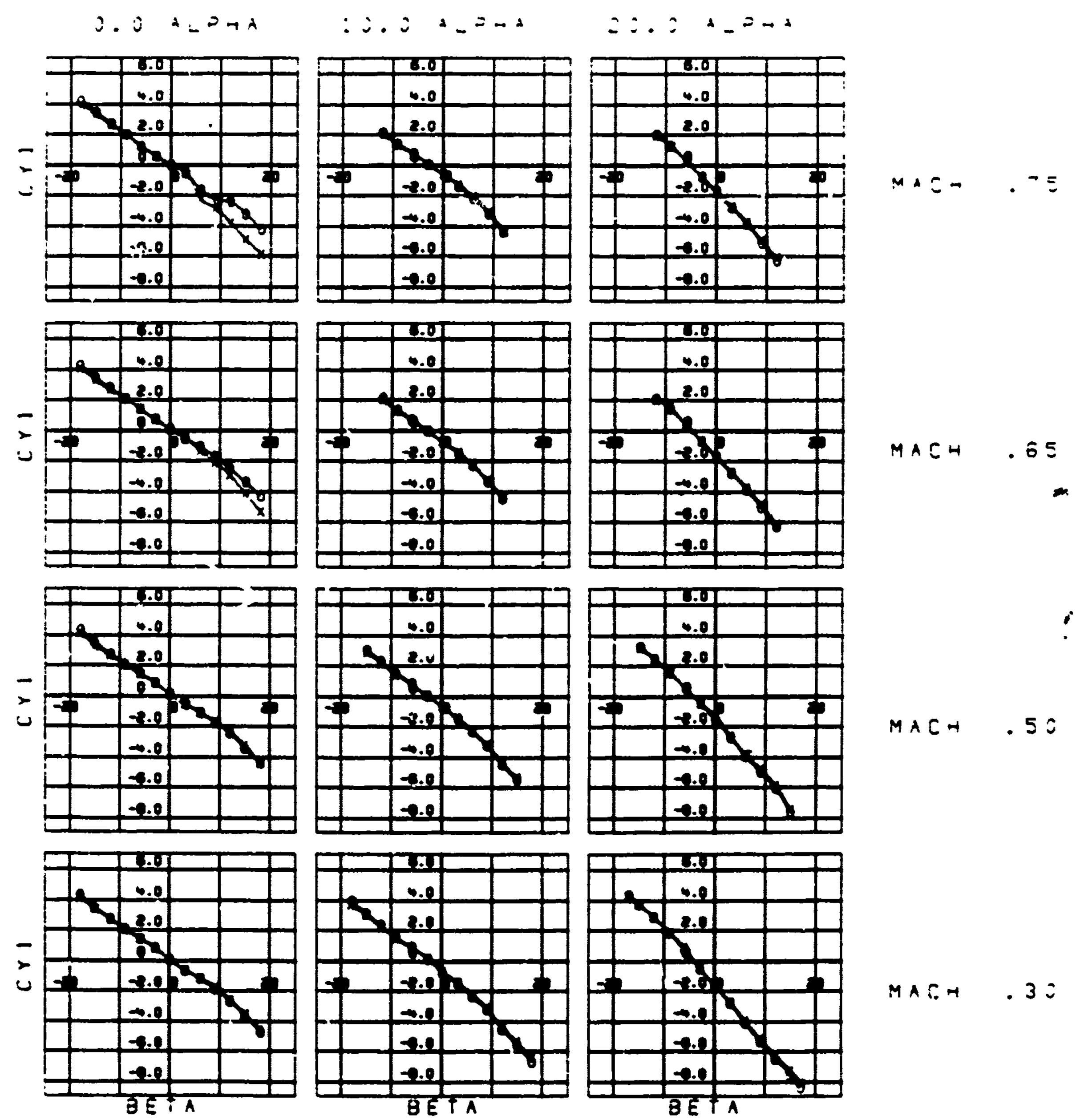


Figure 40. CY, Pylon 1 Versus Pylon 2, Cases 4, 11

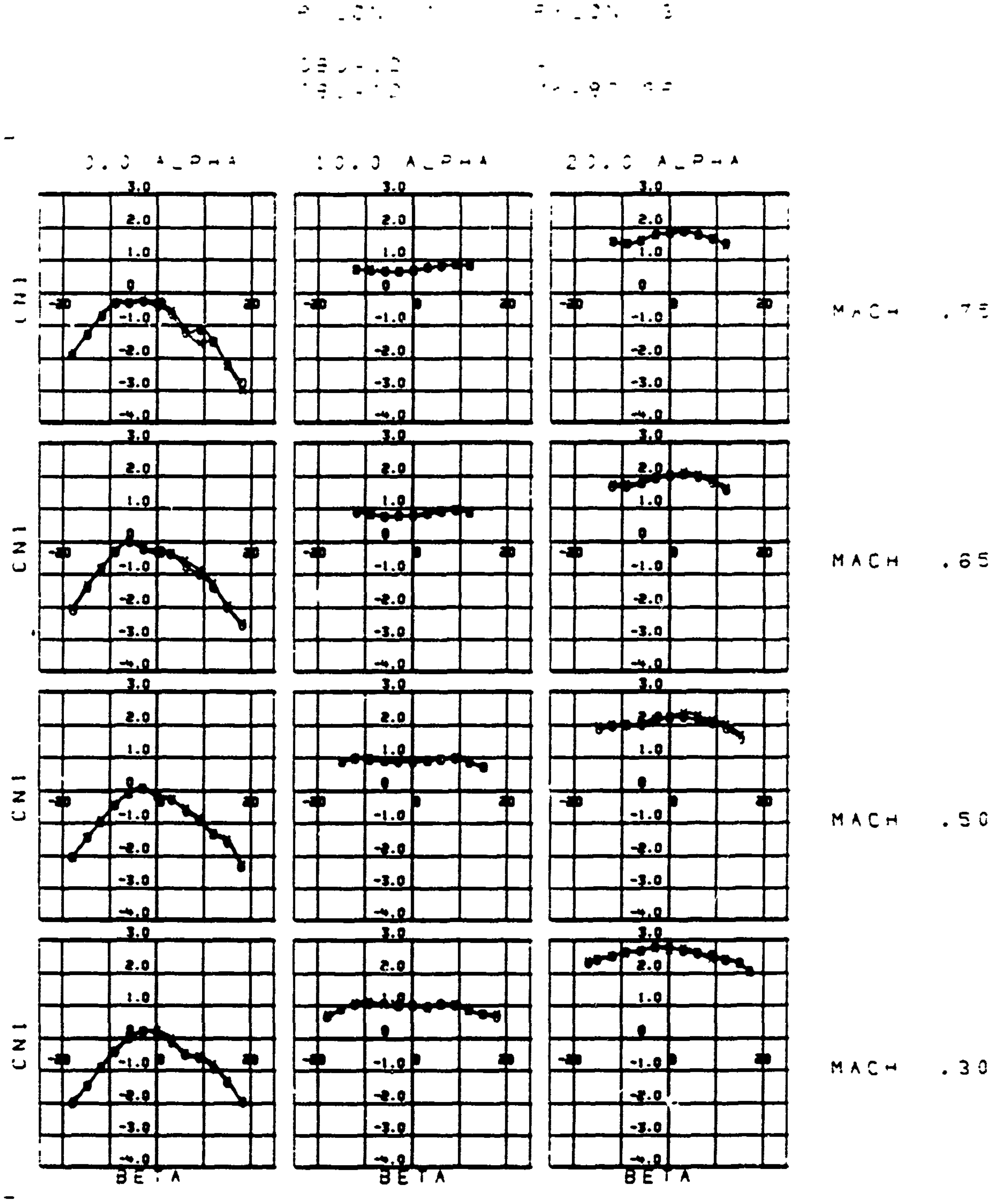


Figure 41. CN, Pylon 1 Versus Pylon 3, Cases 4, 12

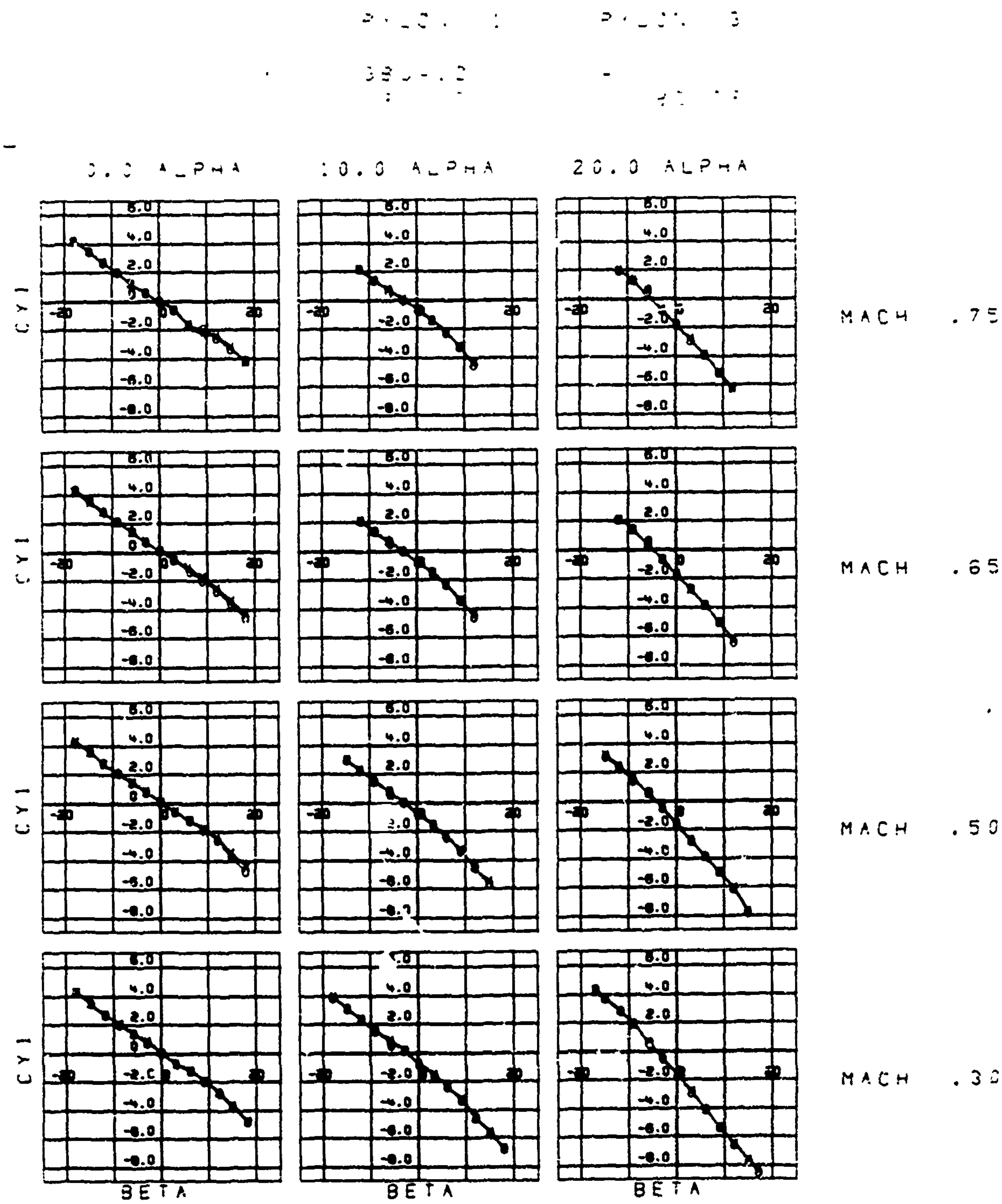


Figure 42. CY, Pylon 1 Versus Pylon 3, Cases 4, 12

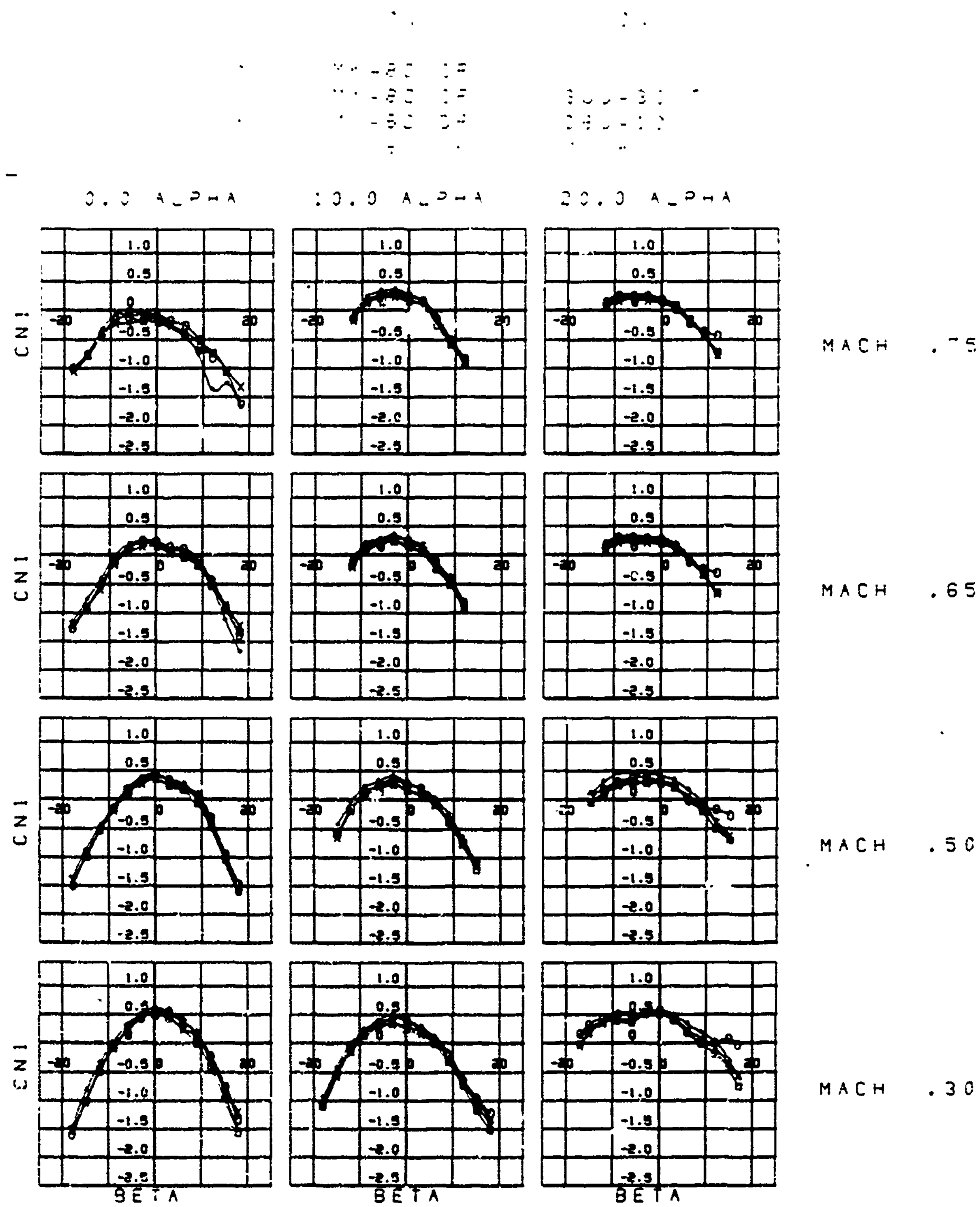


Figure 43. CN, Pylon 1 Versus Pylon 3, Cases 1, 13, 14, 15

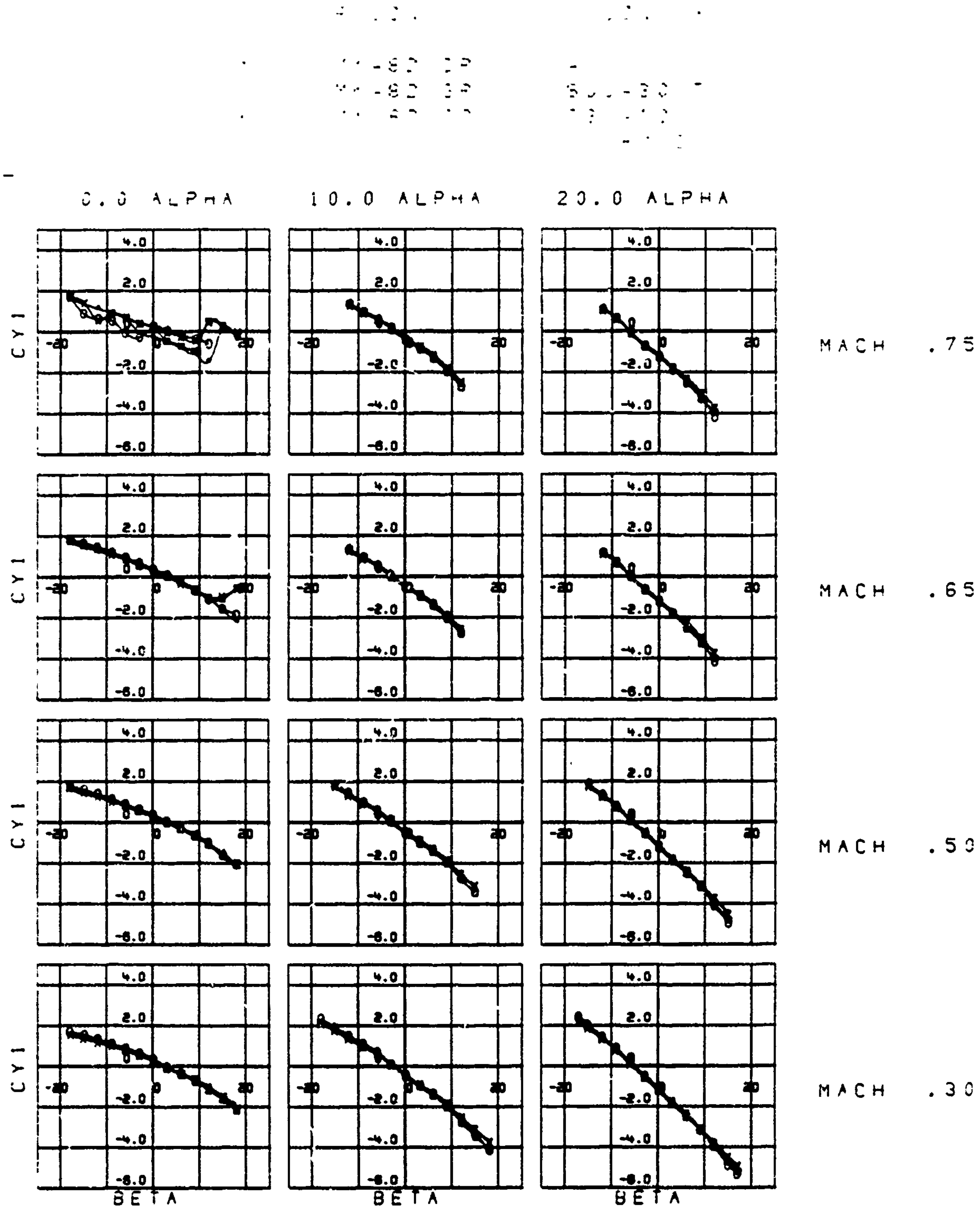


Figure 44. CY, Pylon 1 Versus Pylon 3, Cases 1, 13, 14, 15

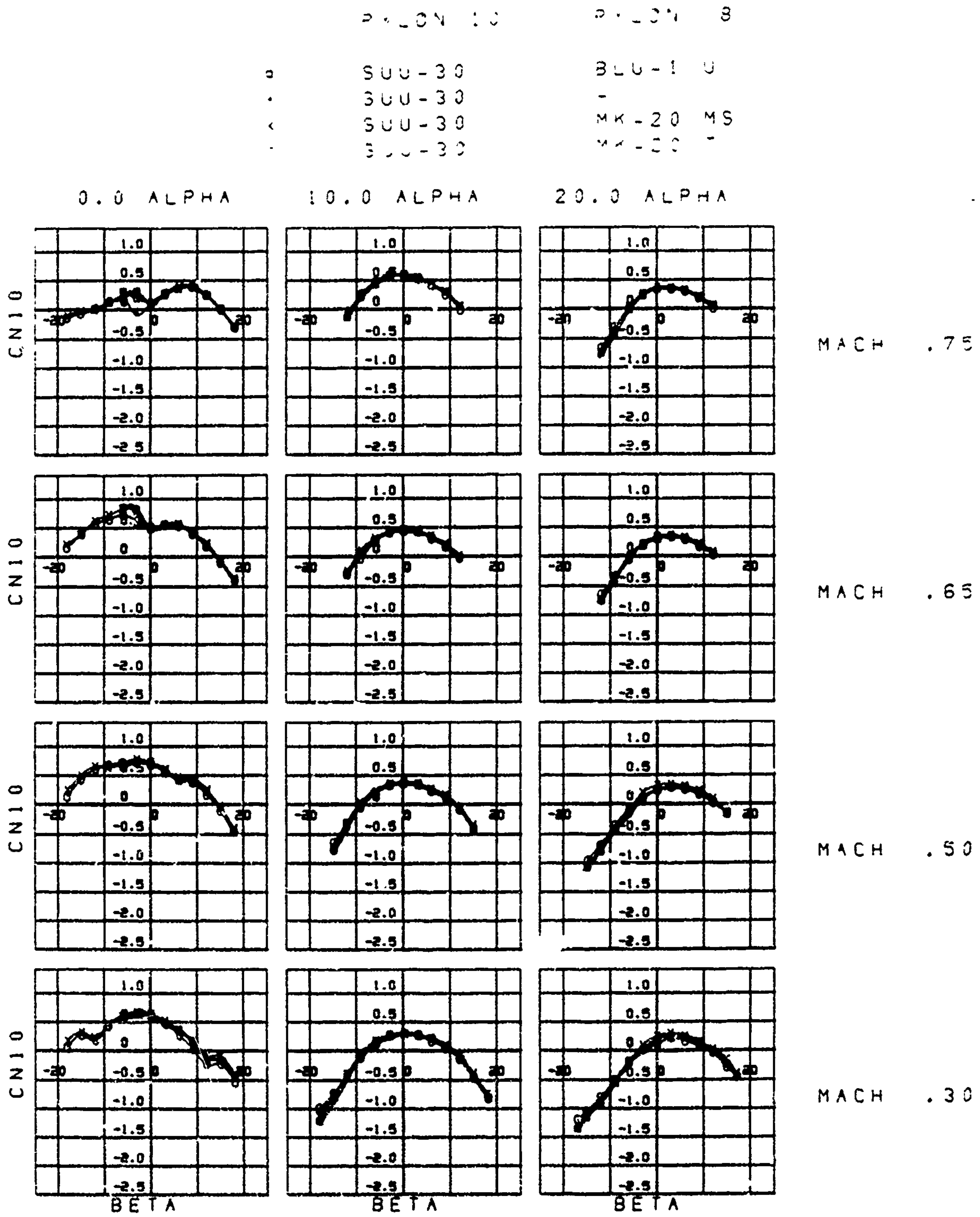


Figure 45. CN, Pylon 10 Versus Pylon 8, Cases 63, 66, 67, 68

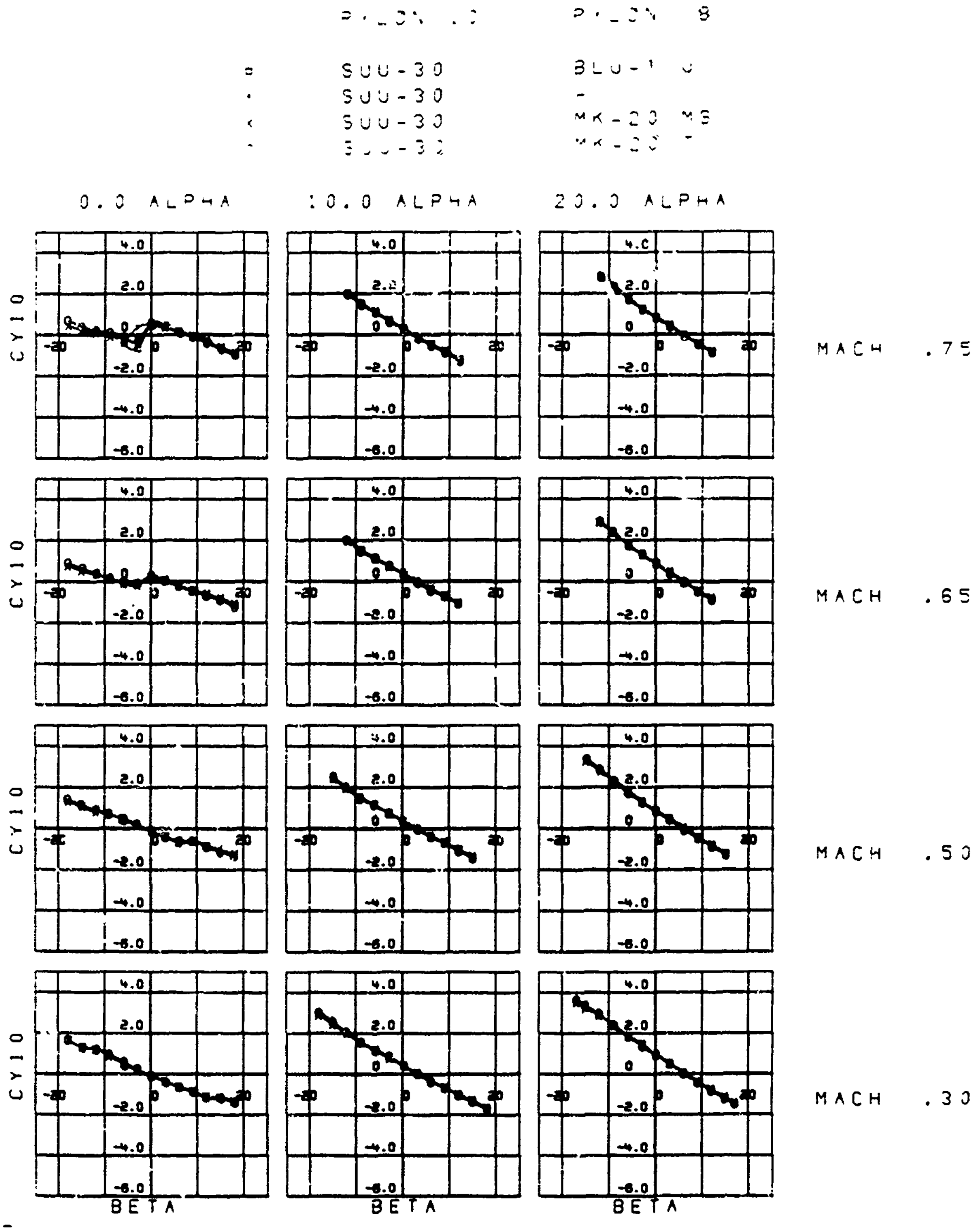


Figure 46. CY, Pylon 10 Versus Pylon 8, Cases 63, 66, 67, 68

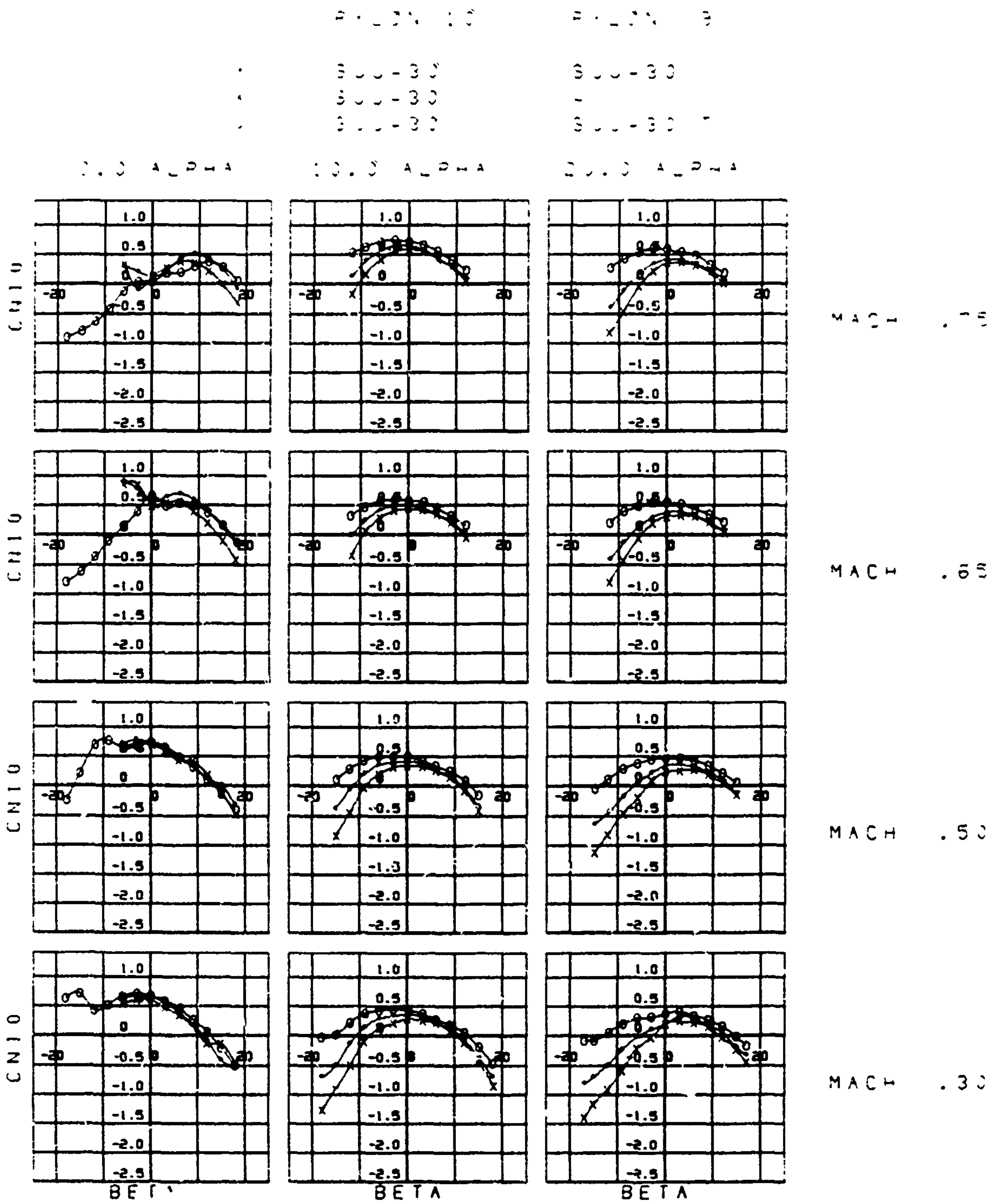


Figure 47. CN, Pylon 10 Versus Pylon 9, Cases 63, 69, 70

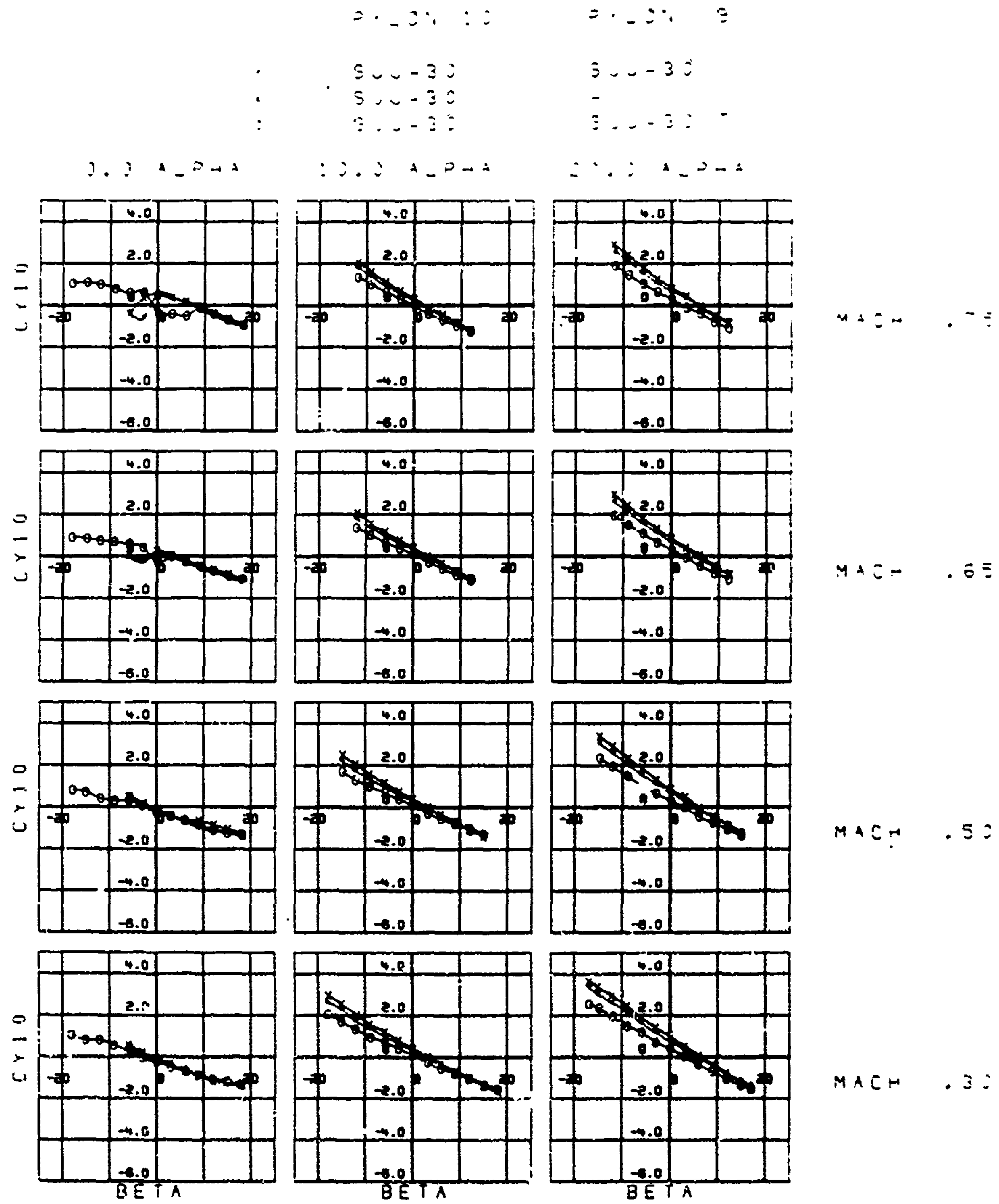


Figure 48. CY, Pylon 10 Versus Pylon 9, Cases 63, 69, 70

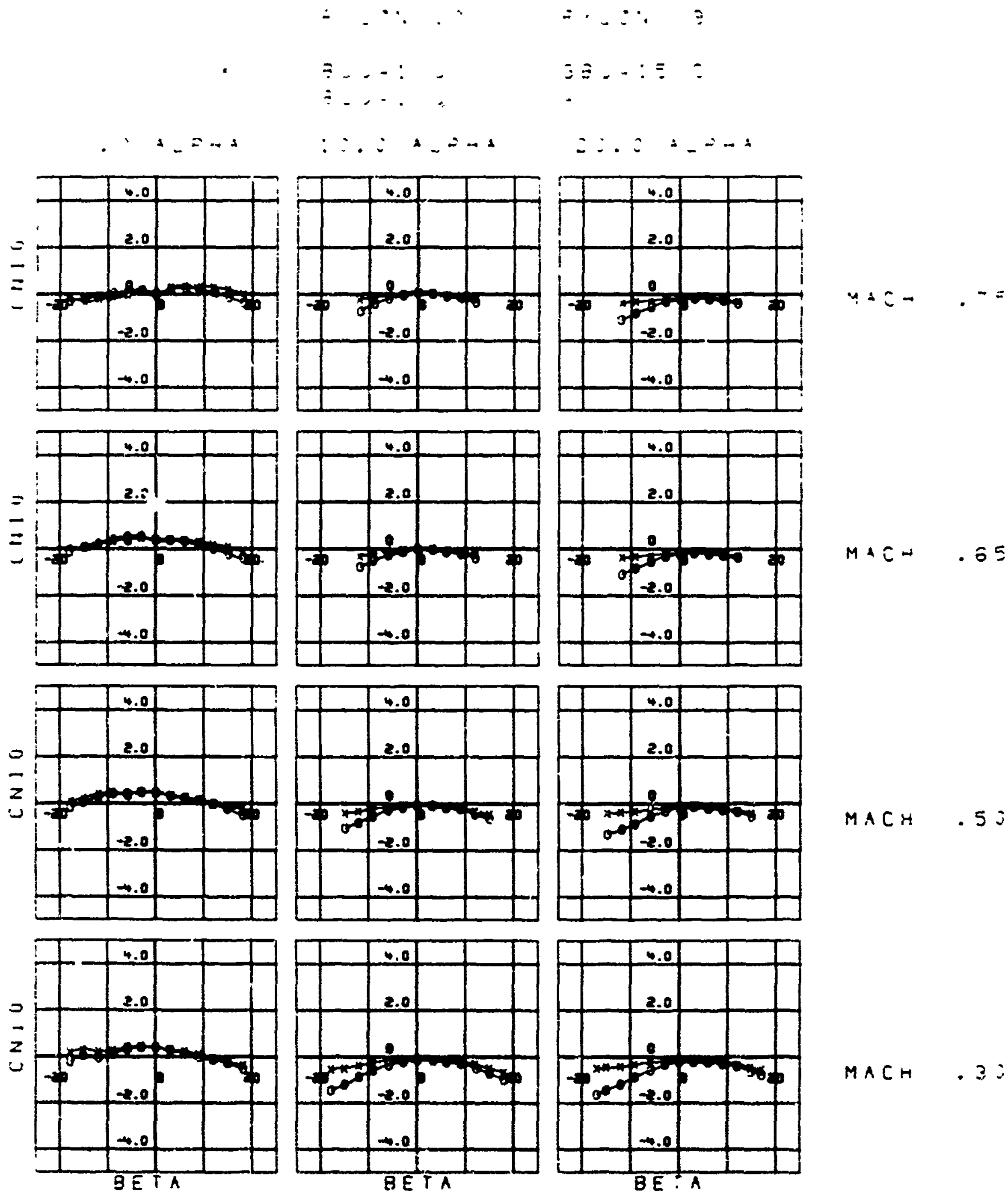


Figure 49. CN, Pylon 10 Versus Pylon 9, Cases 64, 71

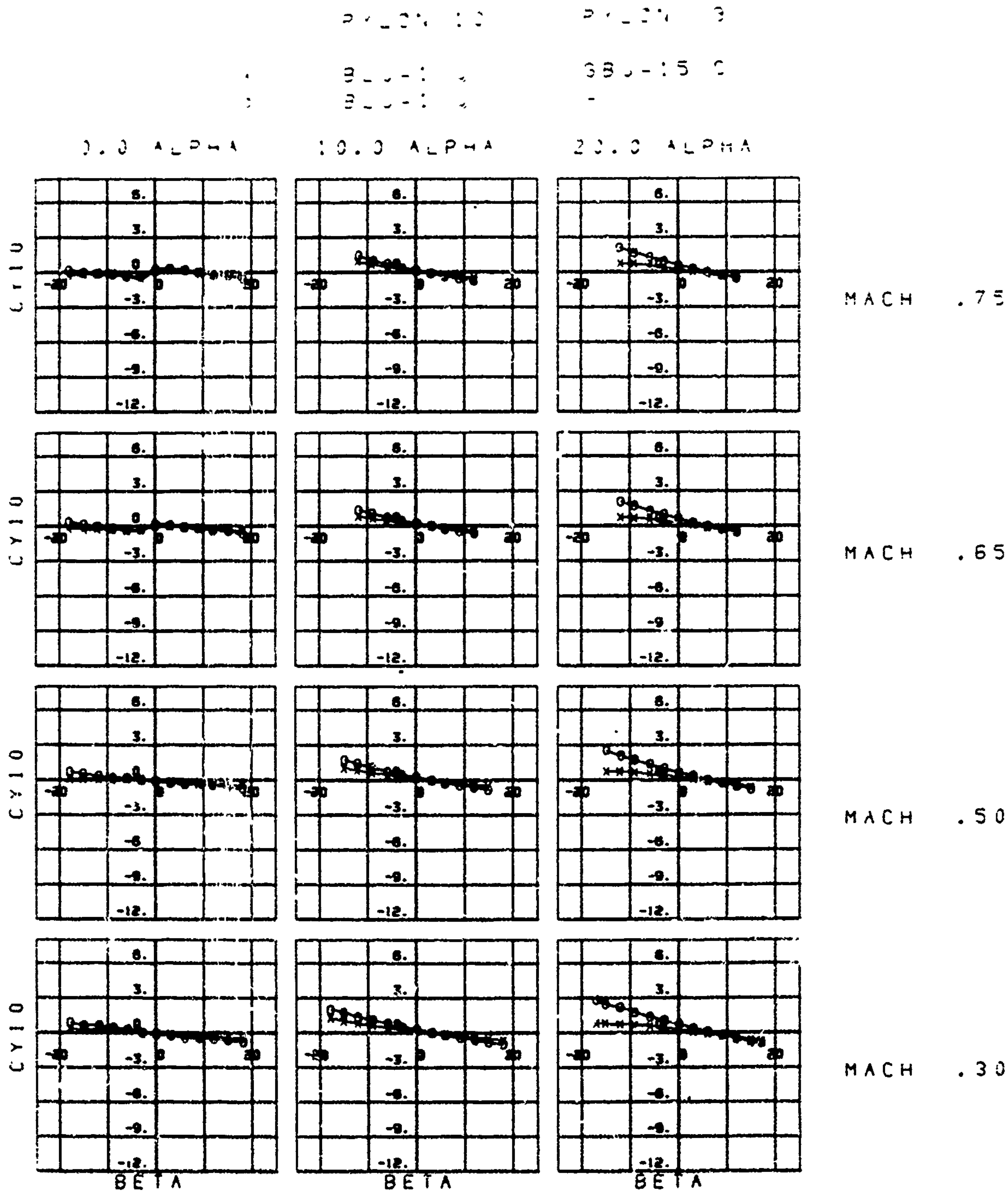


Figure 50. CY, Pylon 10 Versus Pylon 9, Cases 64, 71

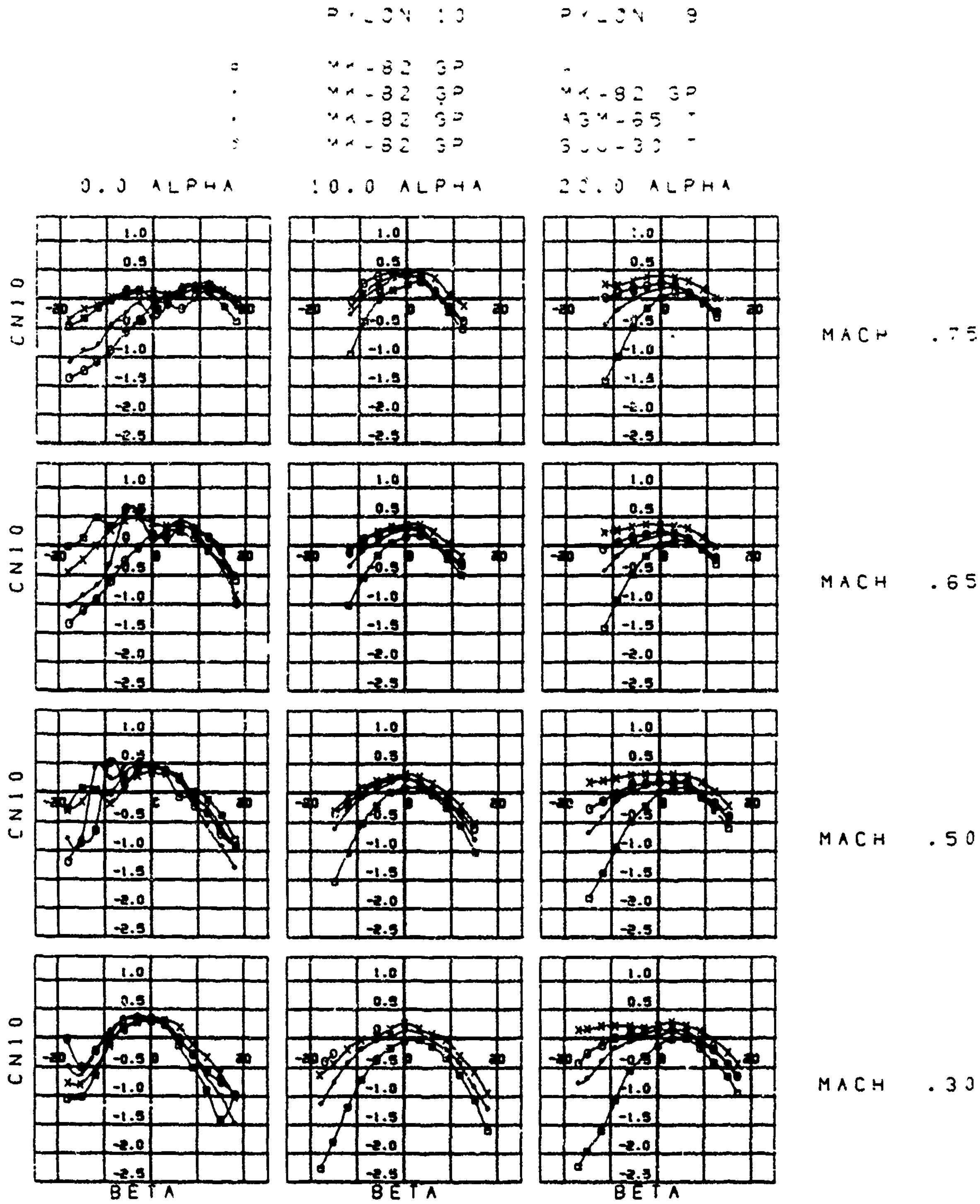


Figure 51. CN, Pylon 10 Versus Pylon 9, Cases 65, 72, 73, 74

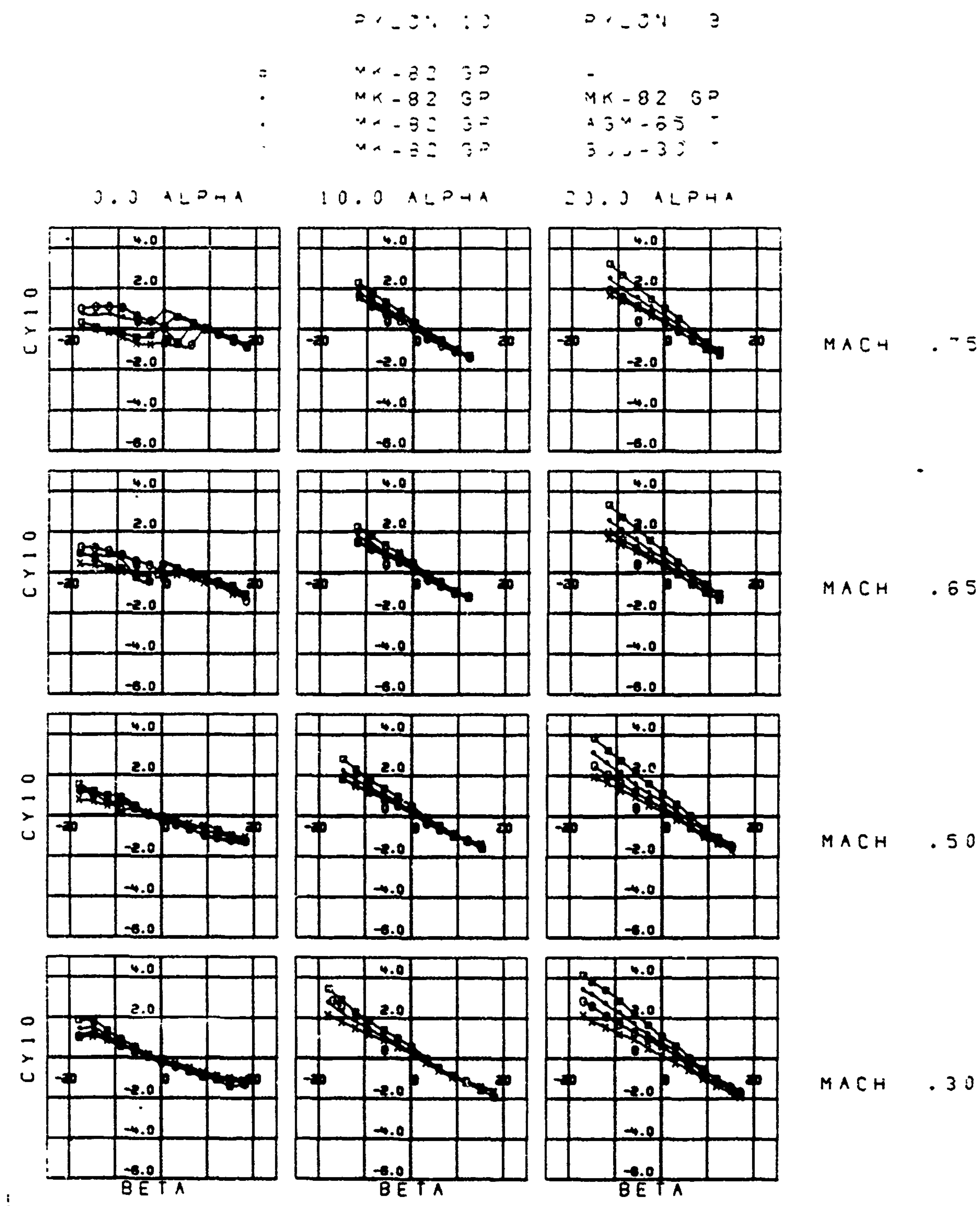


Figure 52. CY, Pylon 10 Versus Pylon 9, Cases 65, 72, 73, 74

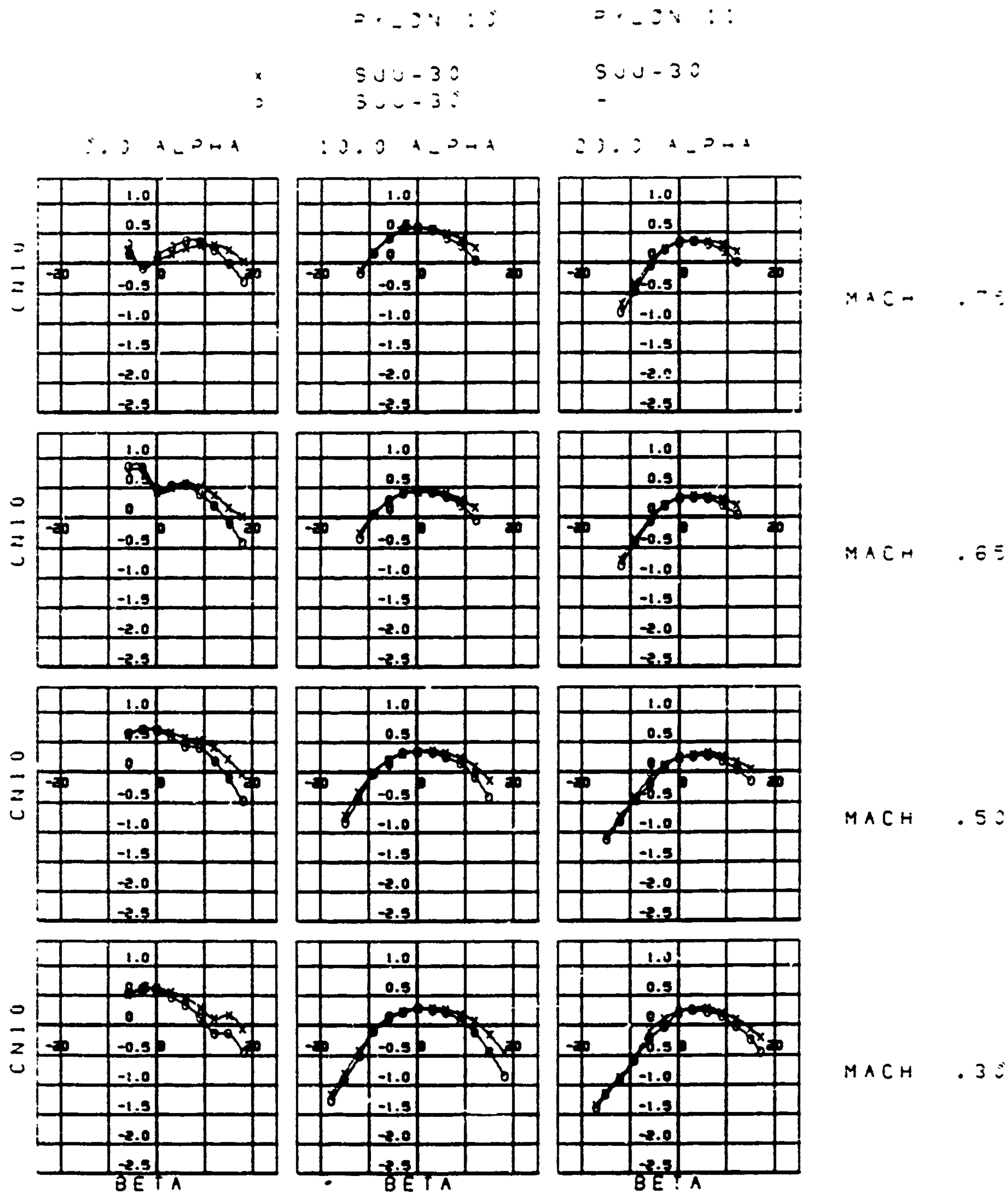


Figure 53. CN, Pylon 10 Versus Pylon 11, Cases 63, 75

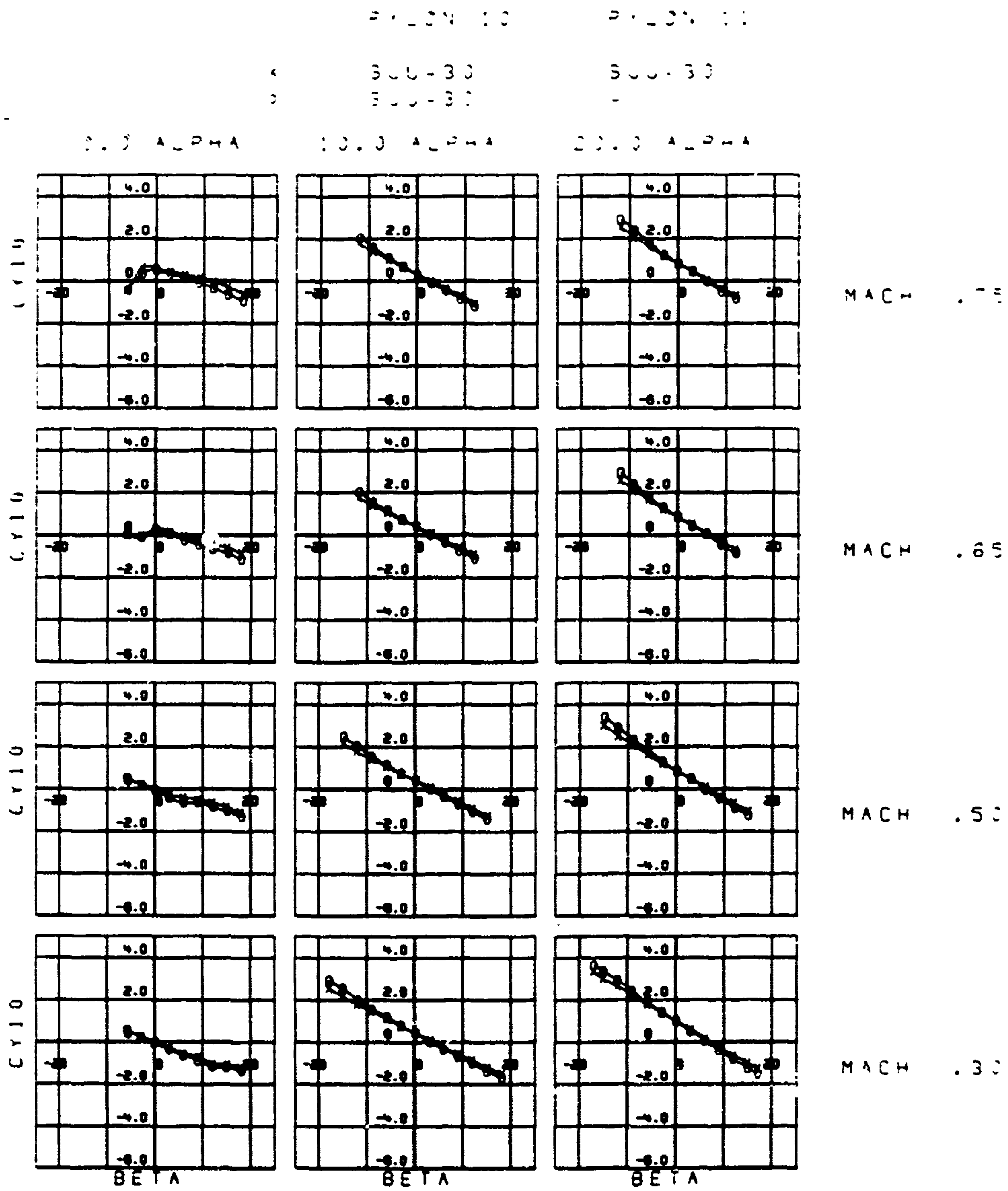


Figure 54. CY, Pylon 10 Versus Pylon 11, Cases 63, 75

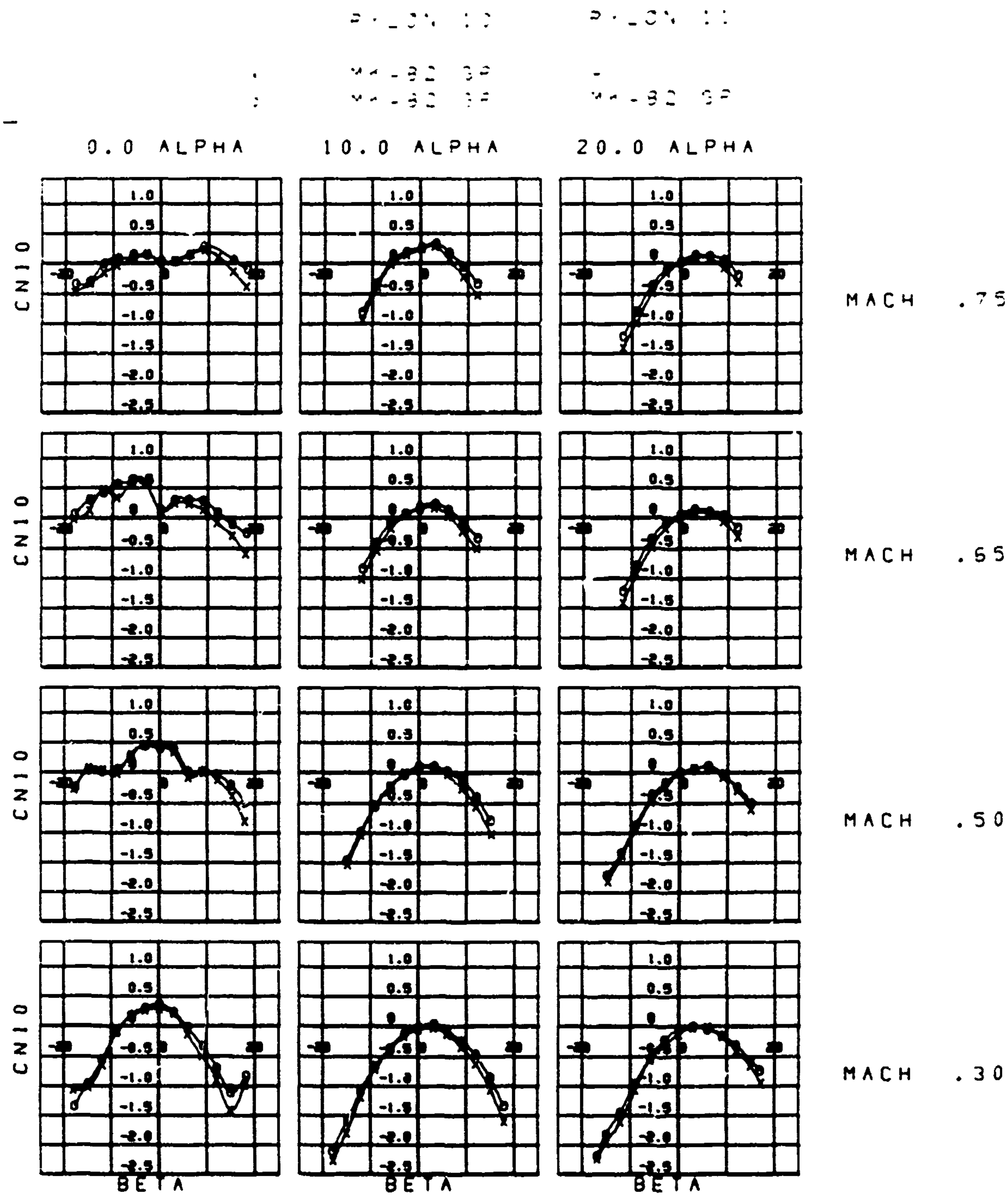


Figure 55. CN, Pylon 10 Versus Pylon 11, Cases 65, 76

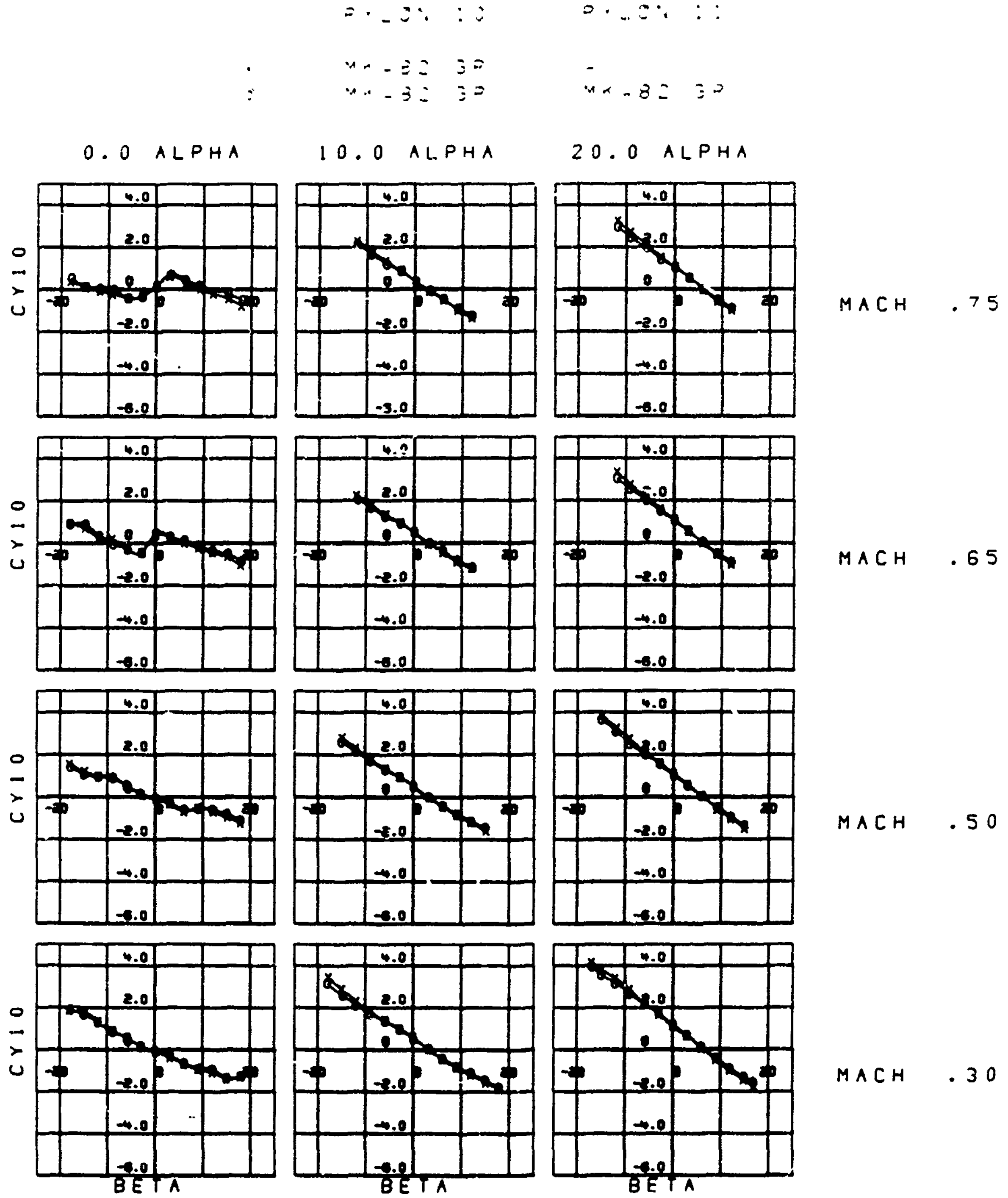


Figure 56. CY, Pylon 10 Versus Pylon 11, Cases 65, 76

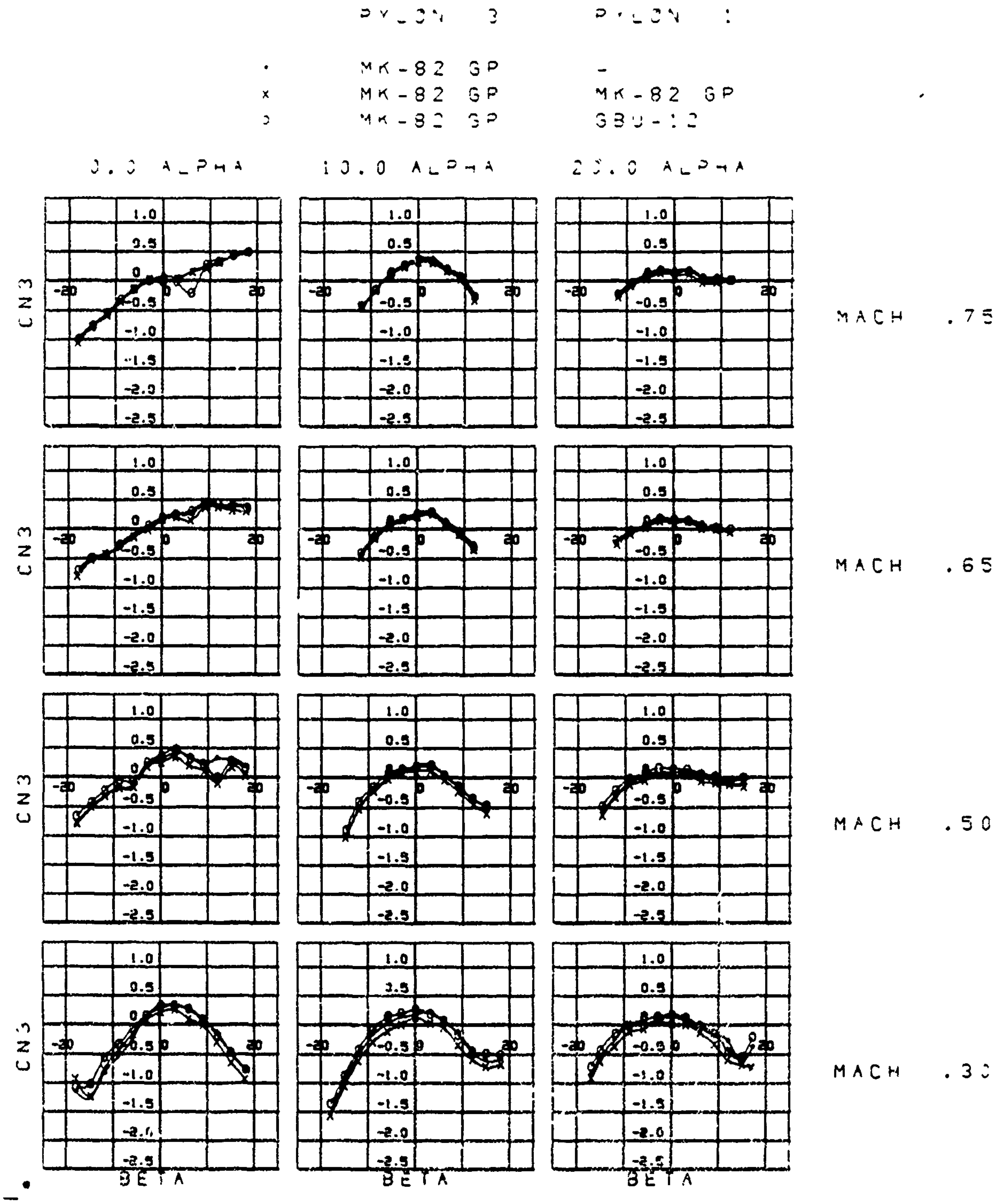


Figure 57. CN, Pylon 3 Versus Pylon 1, Cases 16, 22, 23

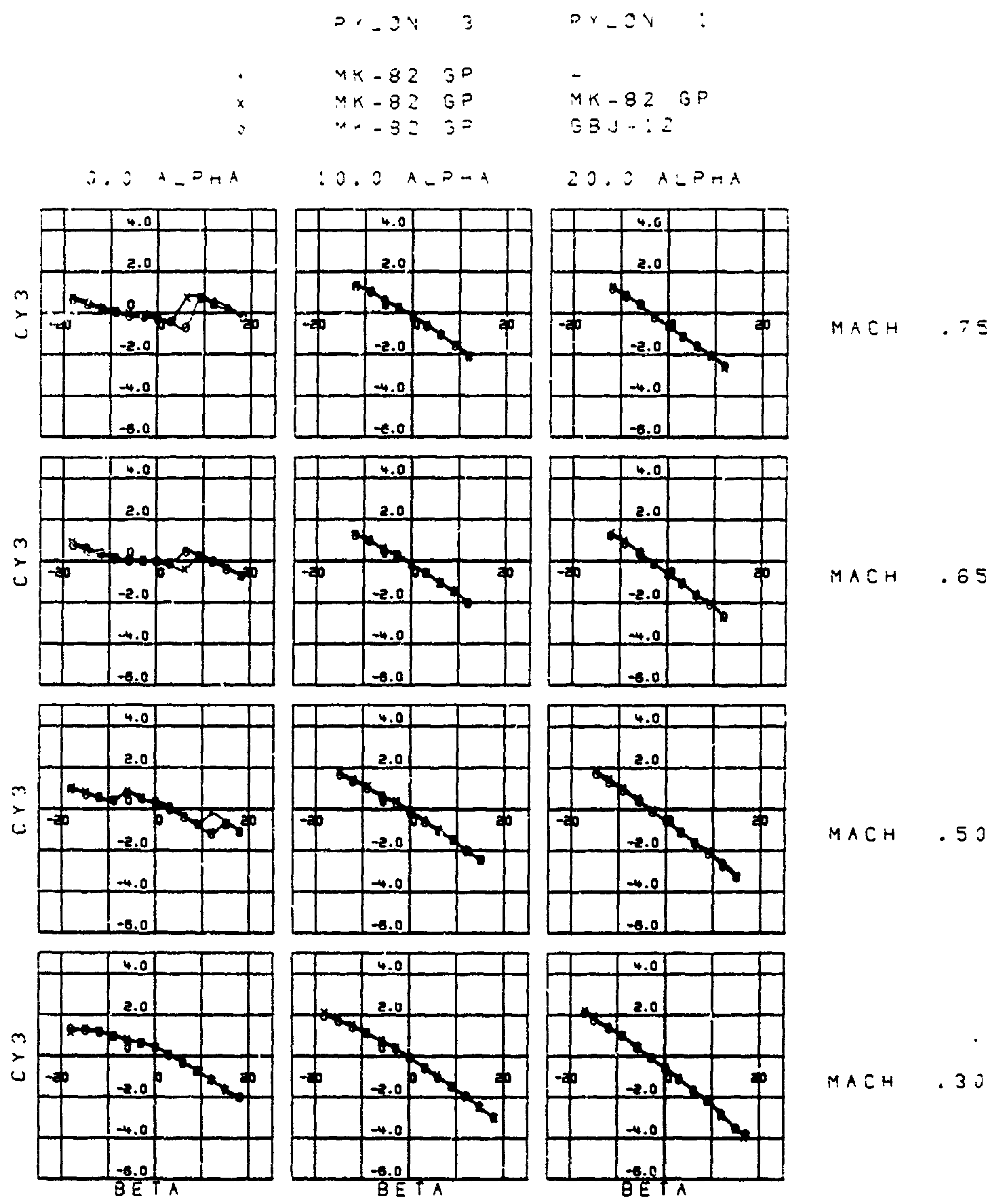


Figure 58. CY, Pylon 3 Versus Pylon 1, Cases 16, 22, 23

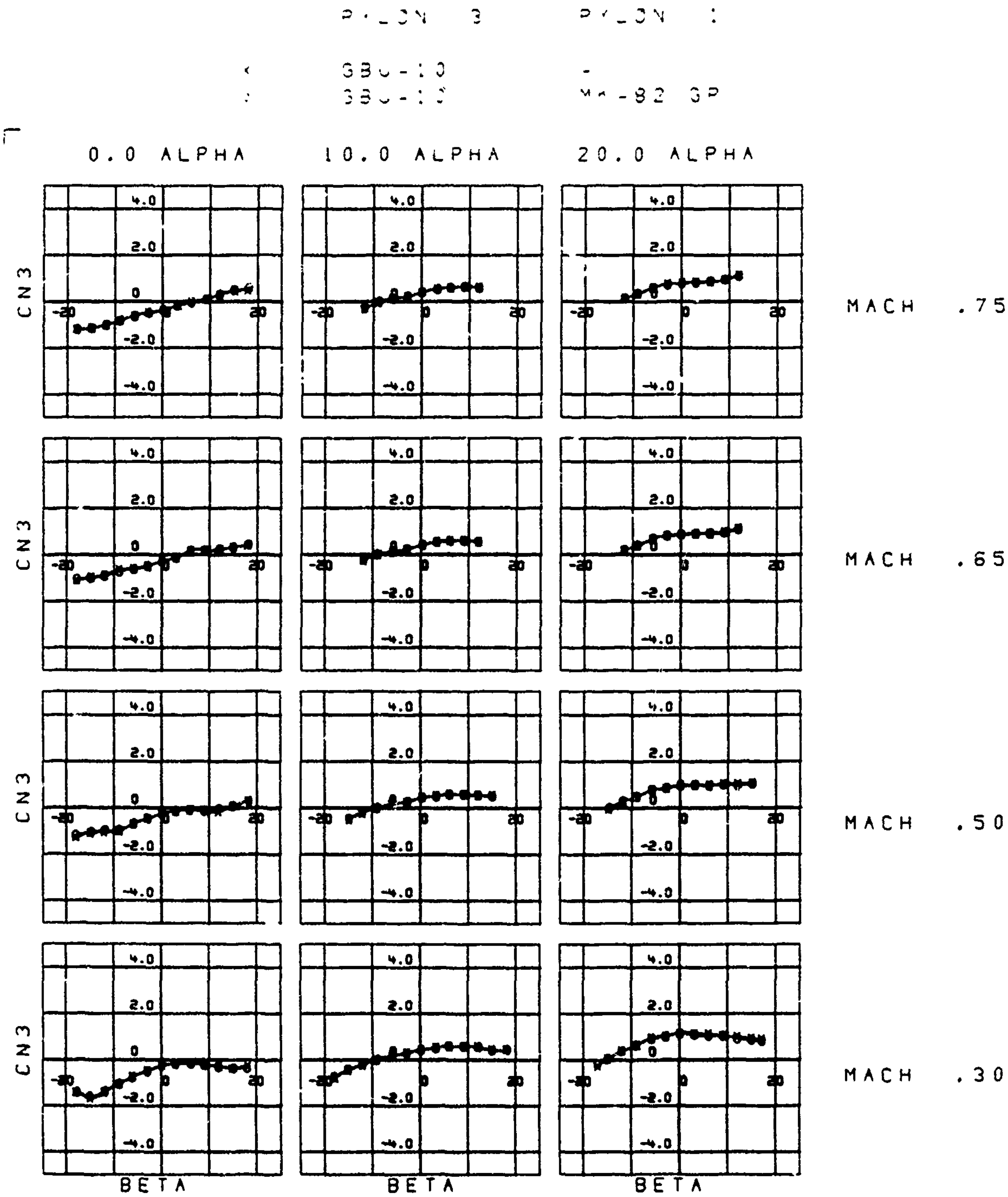


Figure 59. CN, Pylon 3 Versus Pylon 1, Cases 17, 24

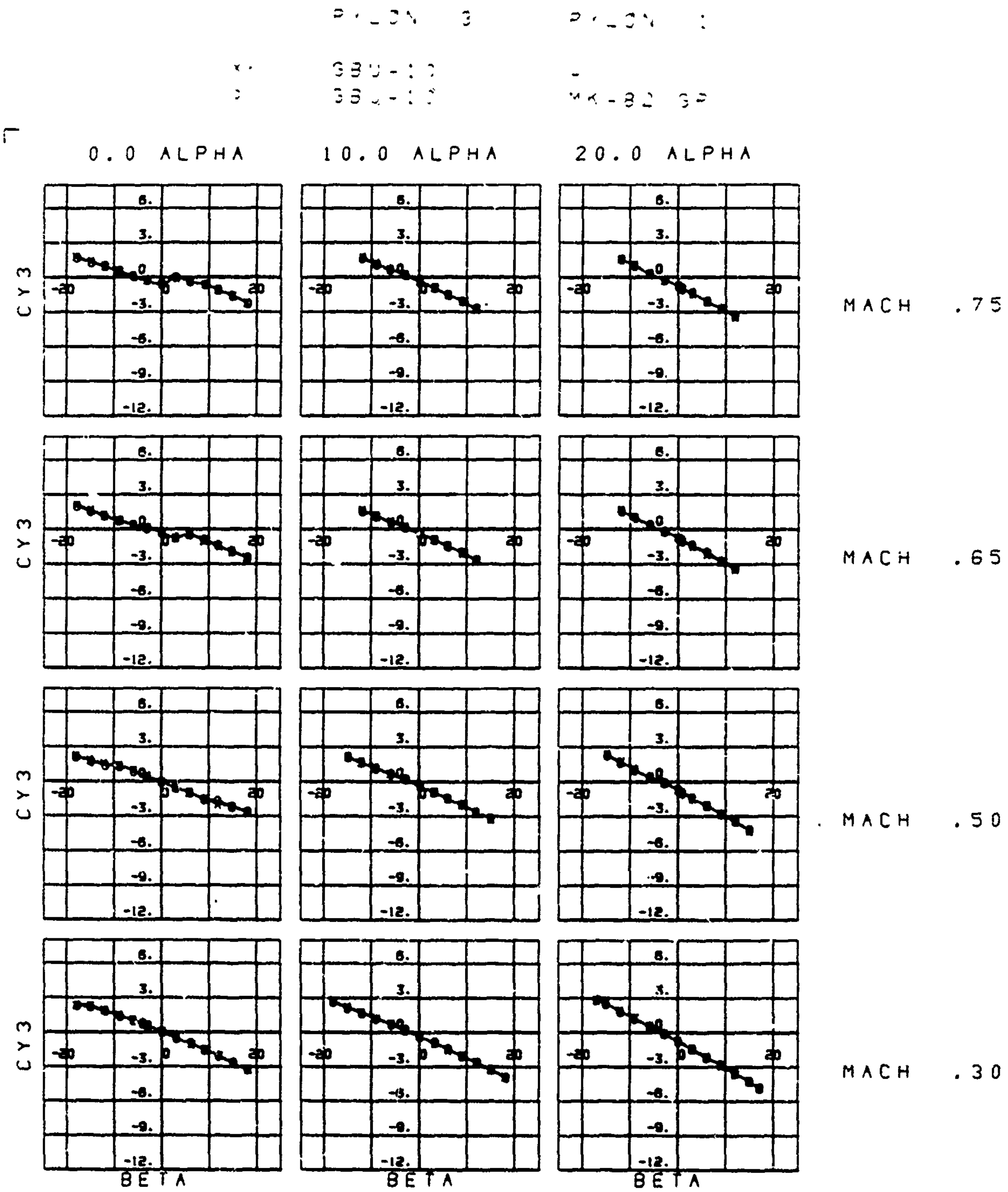


Figure 60. CY, Pylon 3 Versus Pylon 1, Cases 17, 24

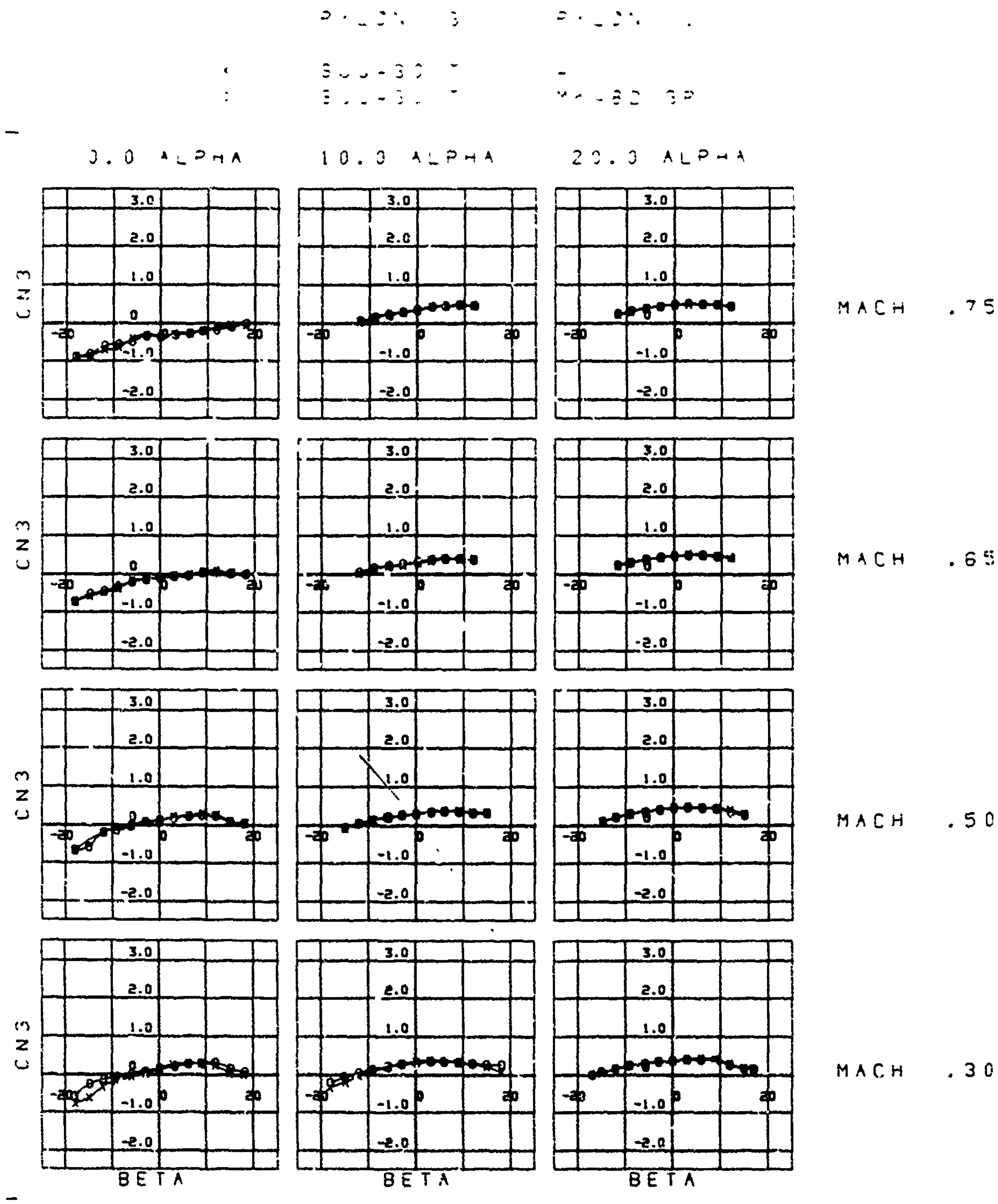


Figure 61. CN, Pylon 3 Versus Pylon 1, Cases 20, 25

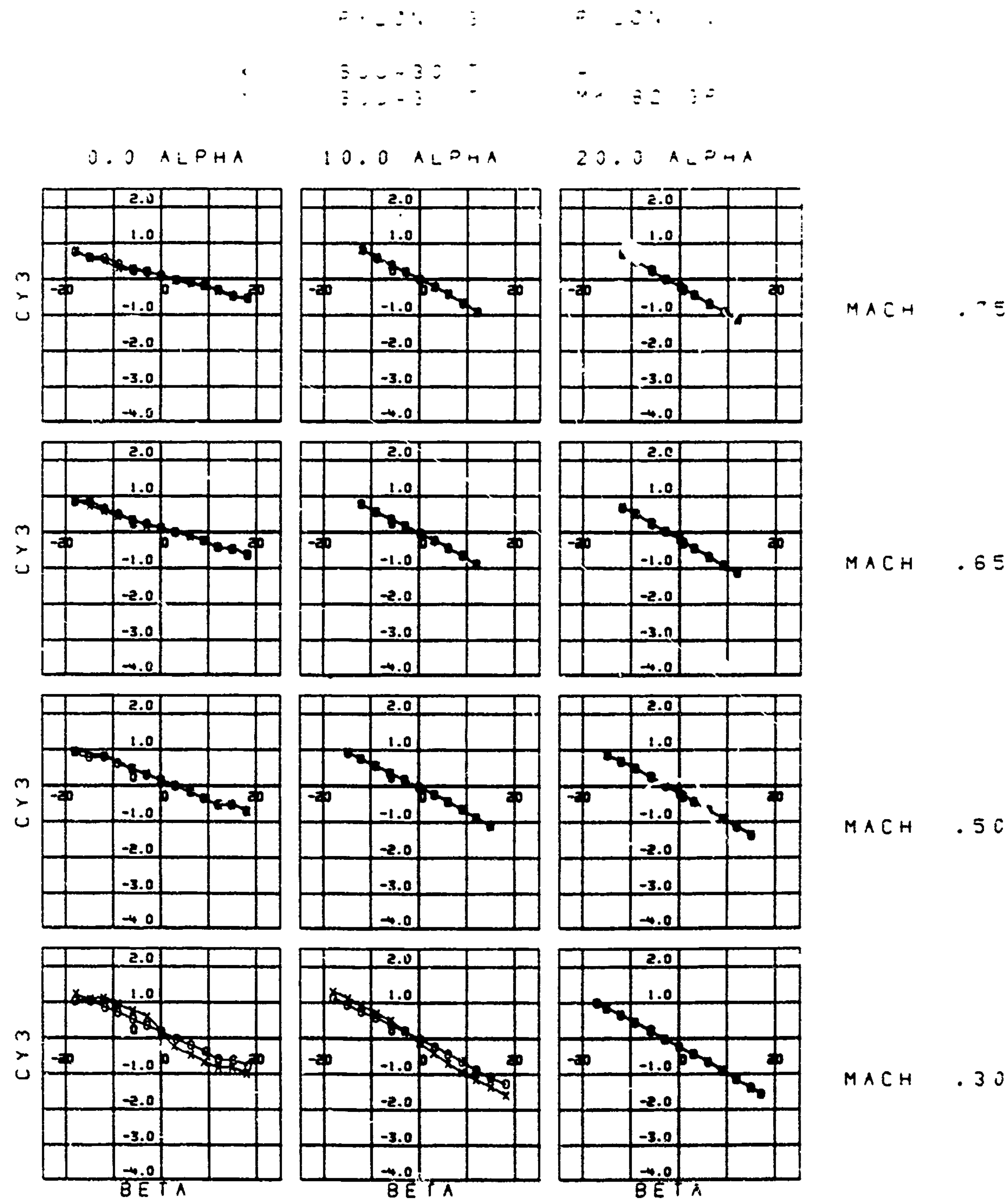


Figure 62. CY, Pylon 3 Versus Pylon 1, Cases 20, 25

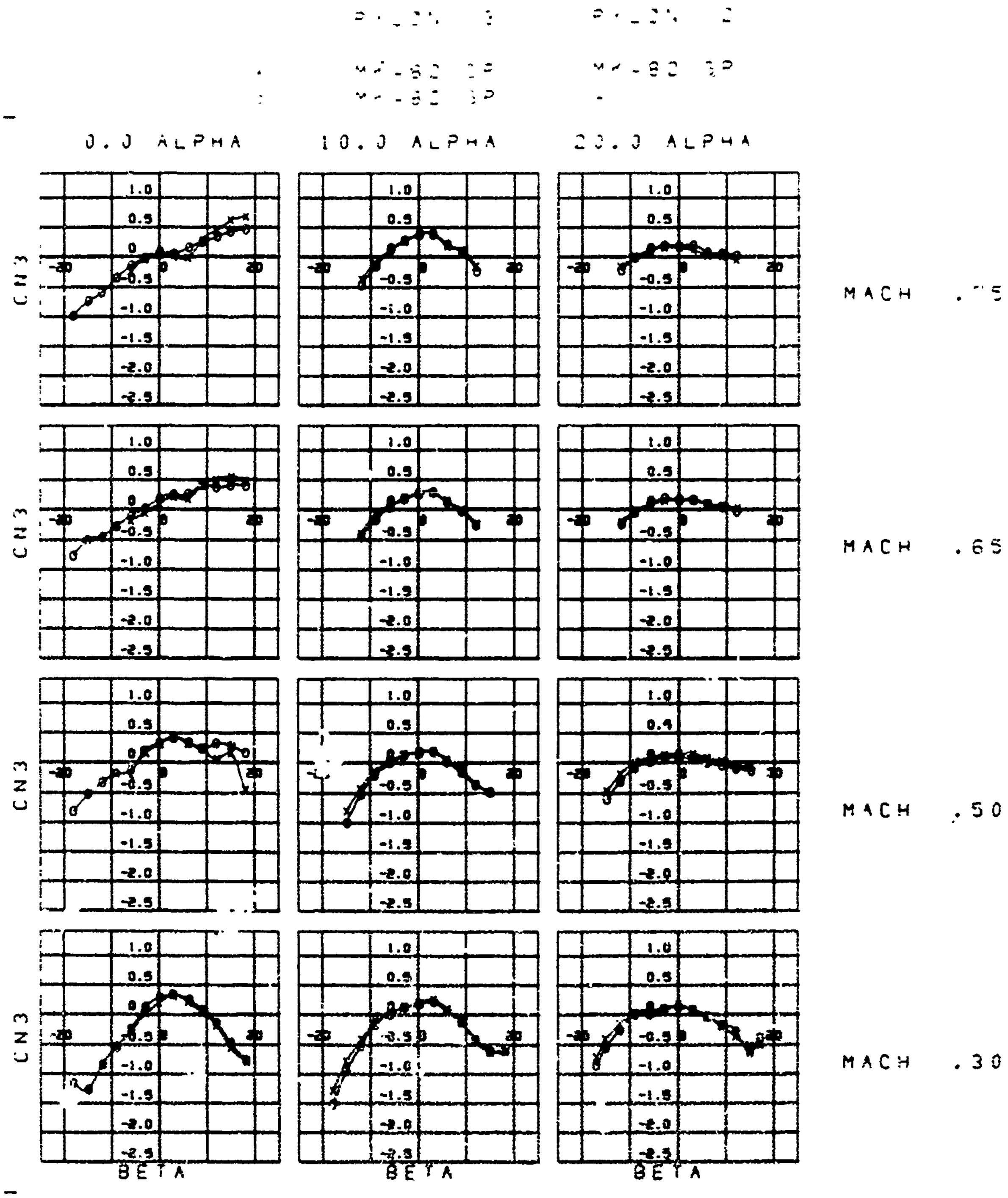


Figure 63. CN, Pylon 3 Versus Pylon 2, Cases 16, 26

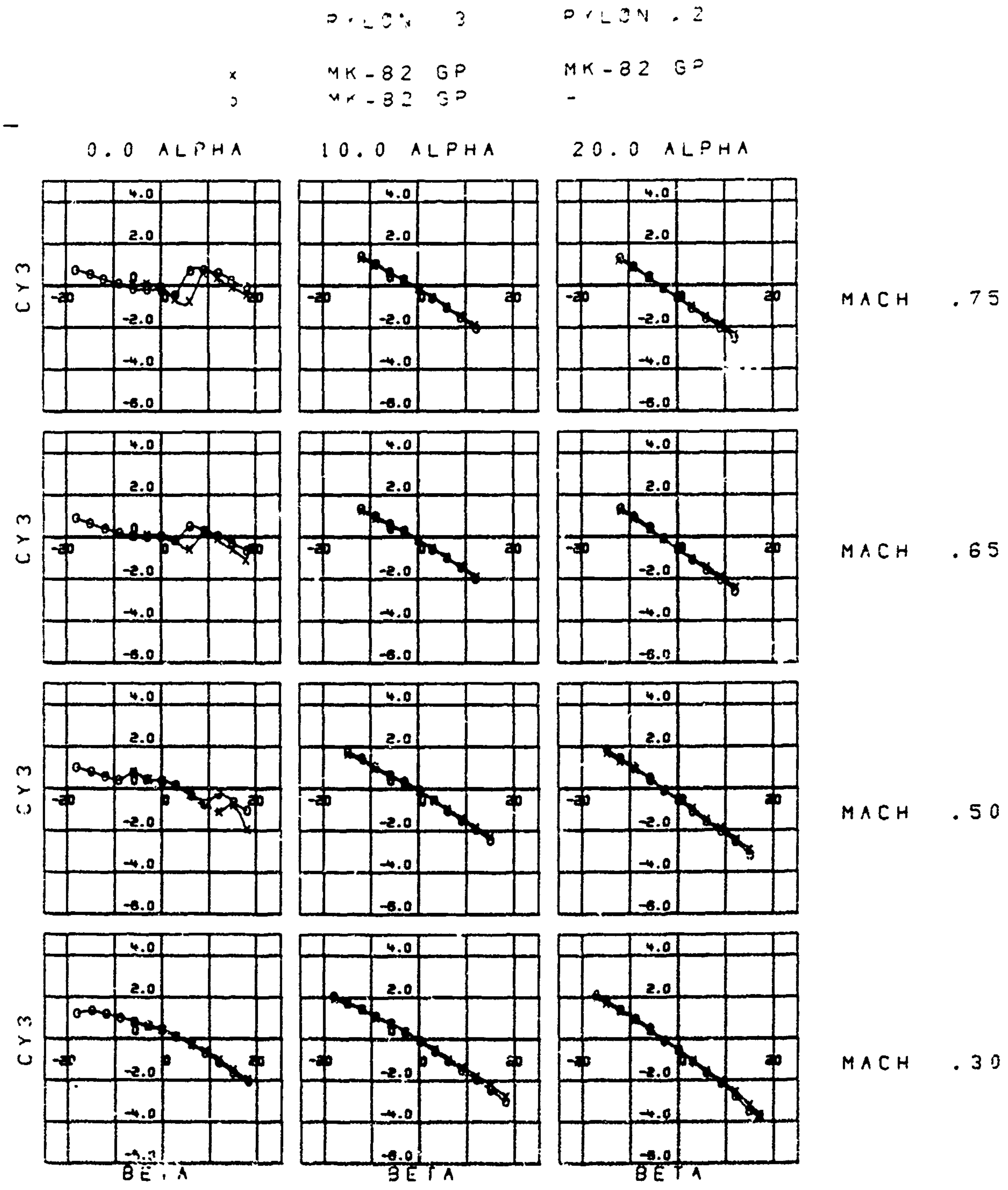


Figure 64. CY, Pylon 3 Versus Pylon 2, Cases 16, 26

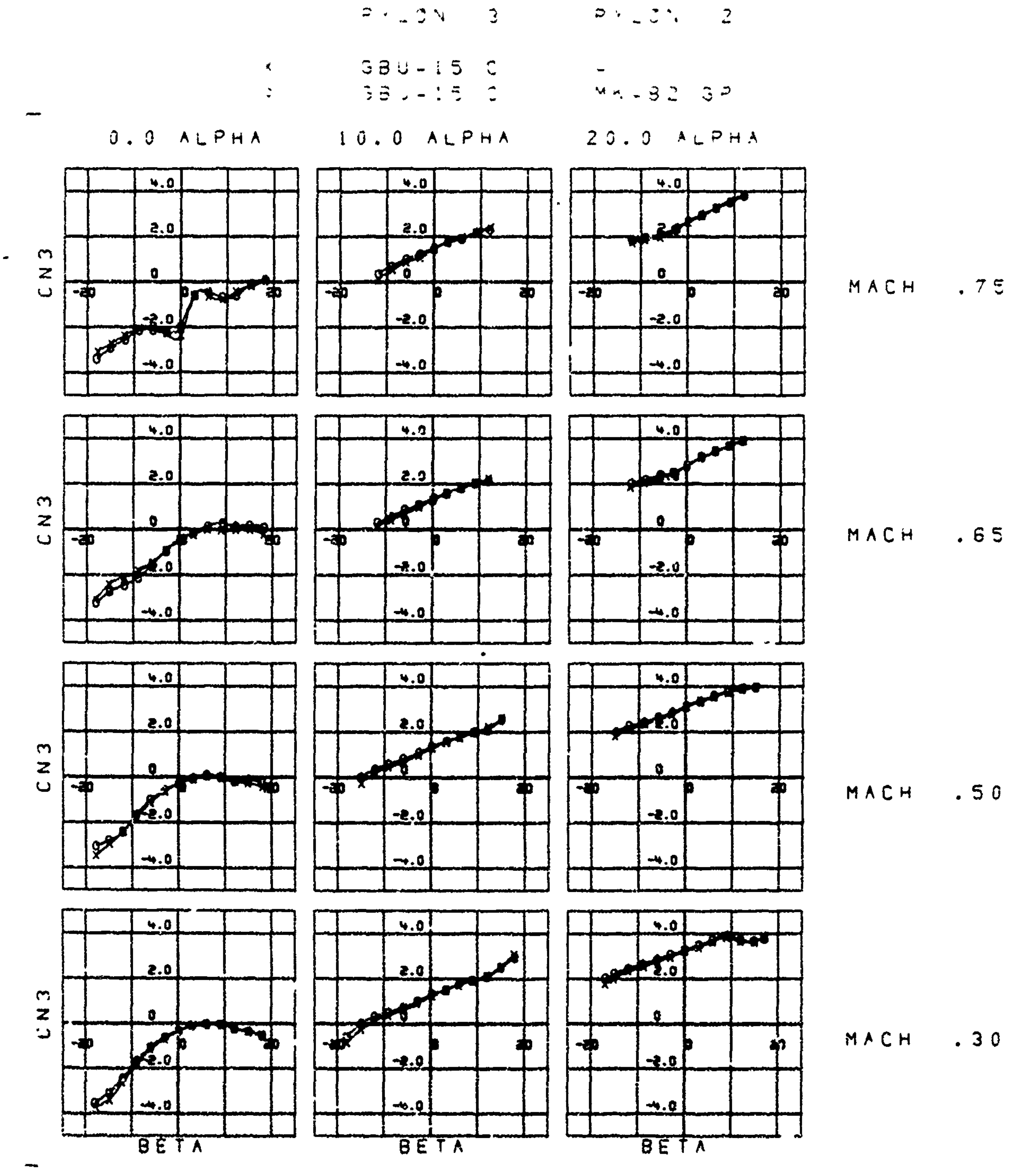


Figure 65. CN, Pylon 3 Versus Pylon 2, Cases 18, 27

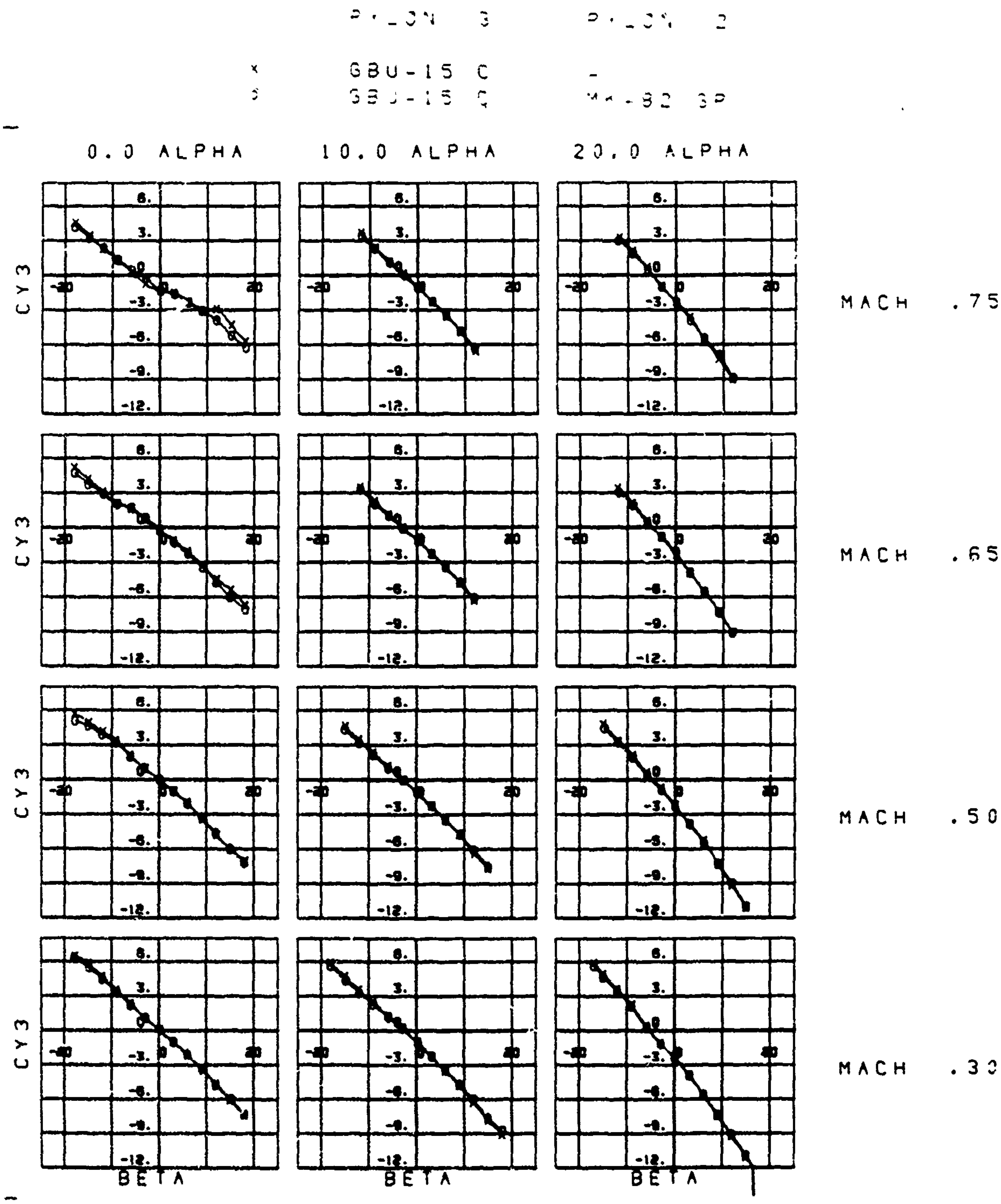


Figure 66. CY, Pylon 3 Versus Pylon 2, Cases 18, 27

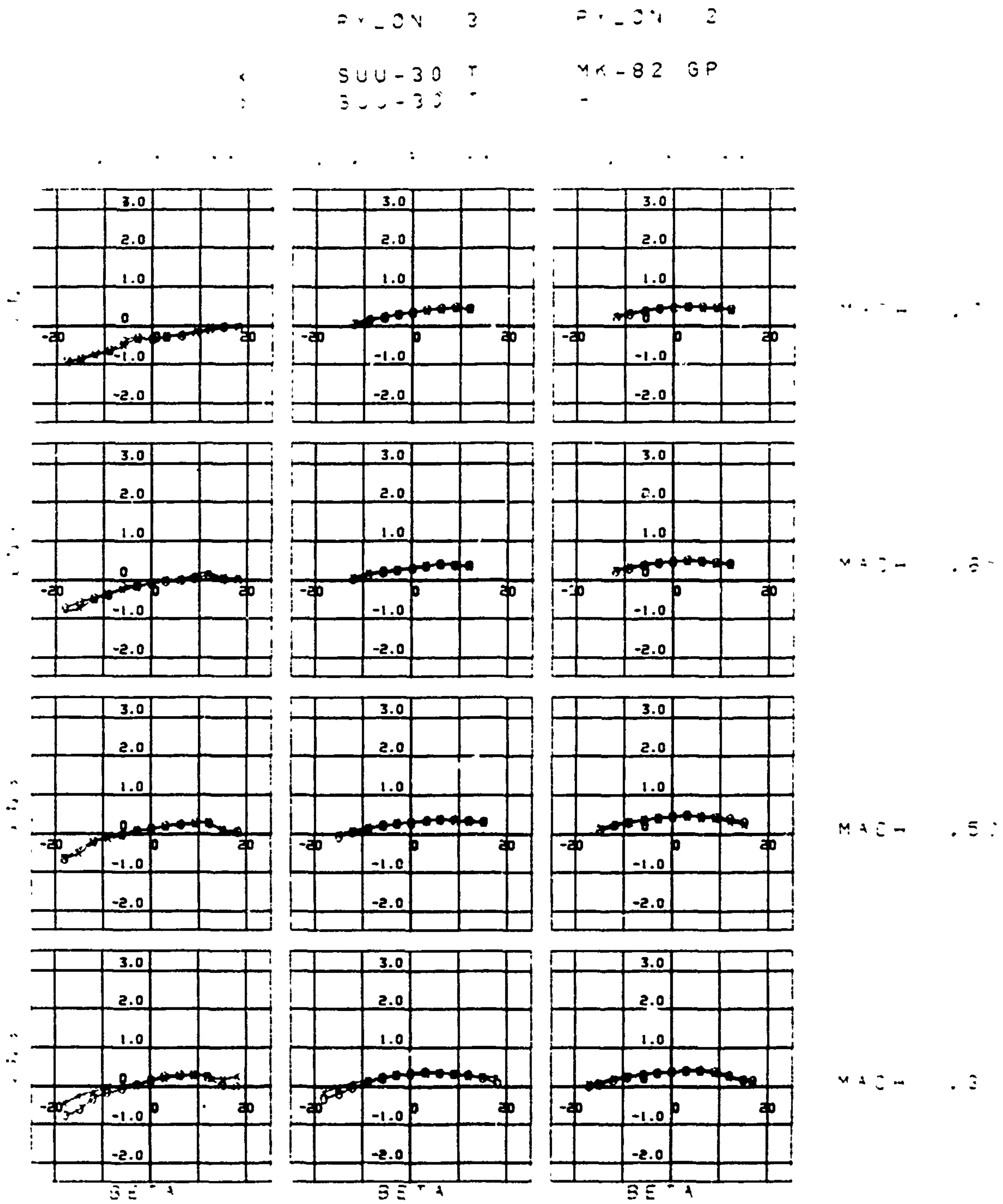


Figure 67. CN, Pylon 3 Versus Pylon 2, Cases 20, 28

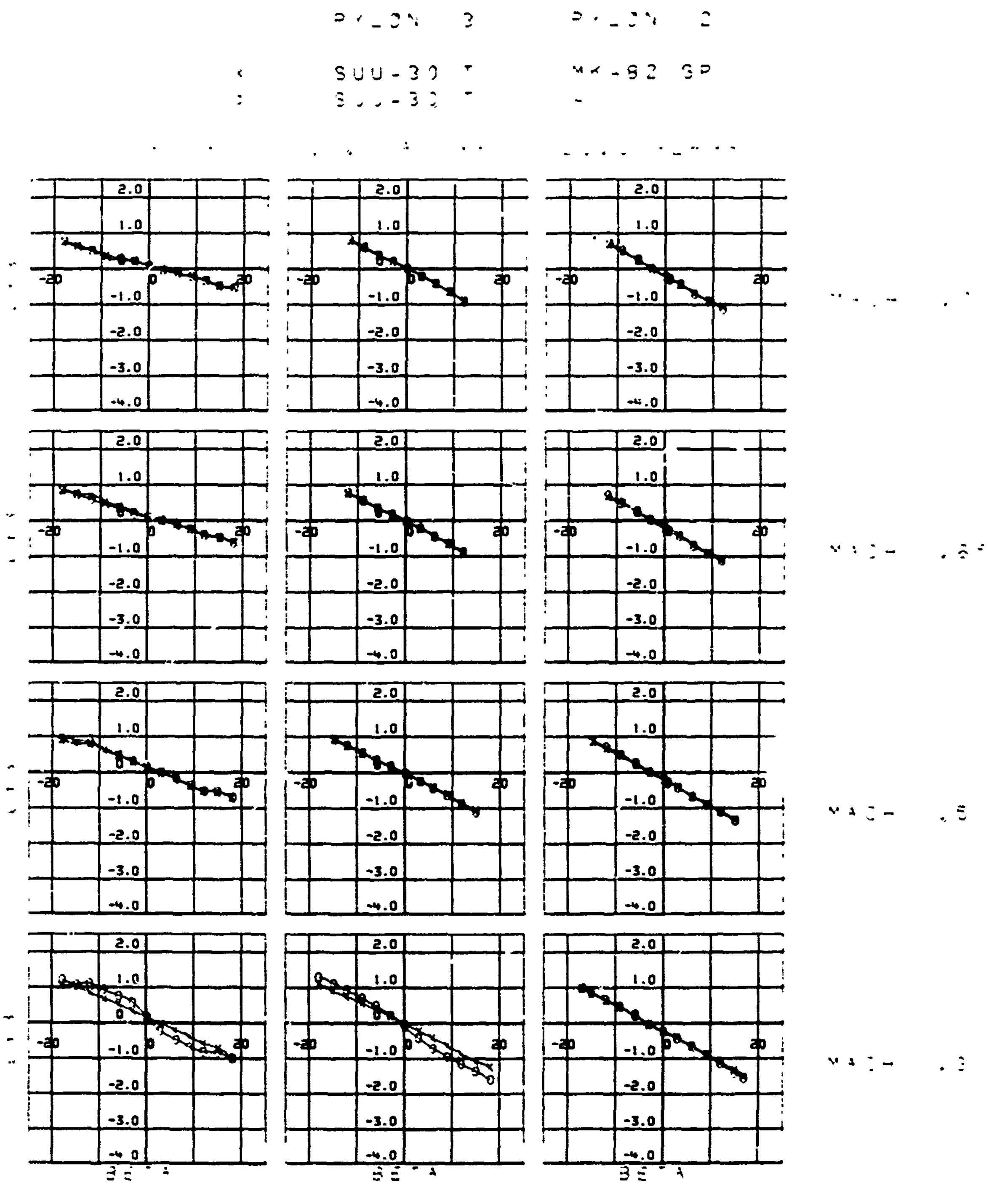


Figure 63. CY, Pylon 3 Versus Pylon 2, Cases 20, 28

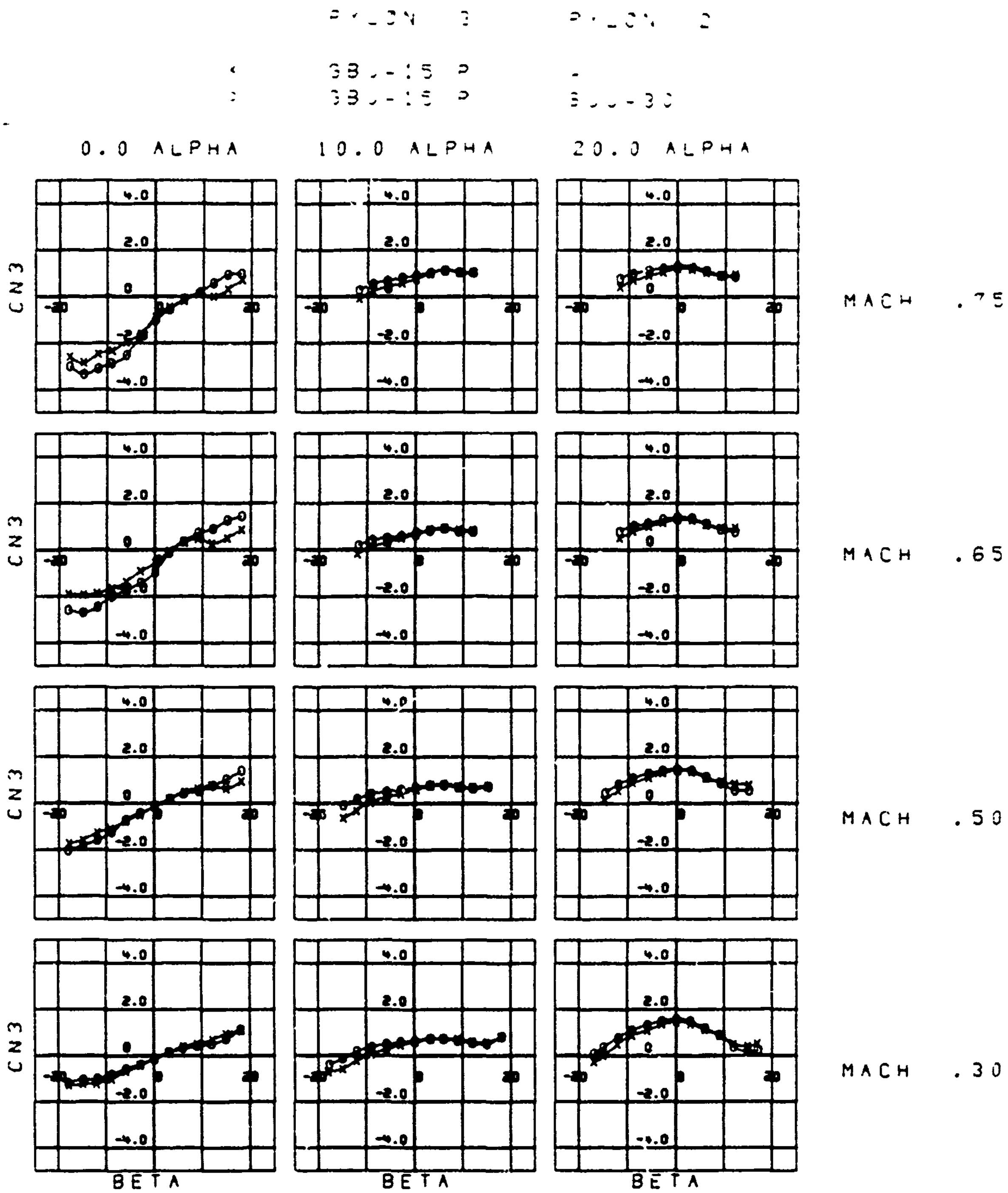


Figure 69. CN, Pylon 3 Versus Pylon 2, Cases 19, 29

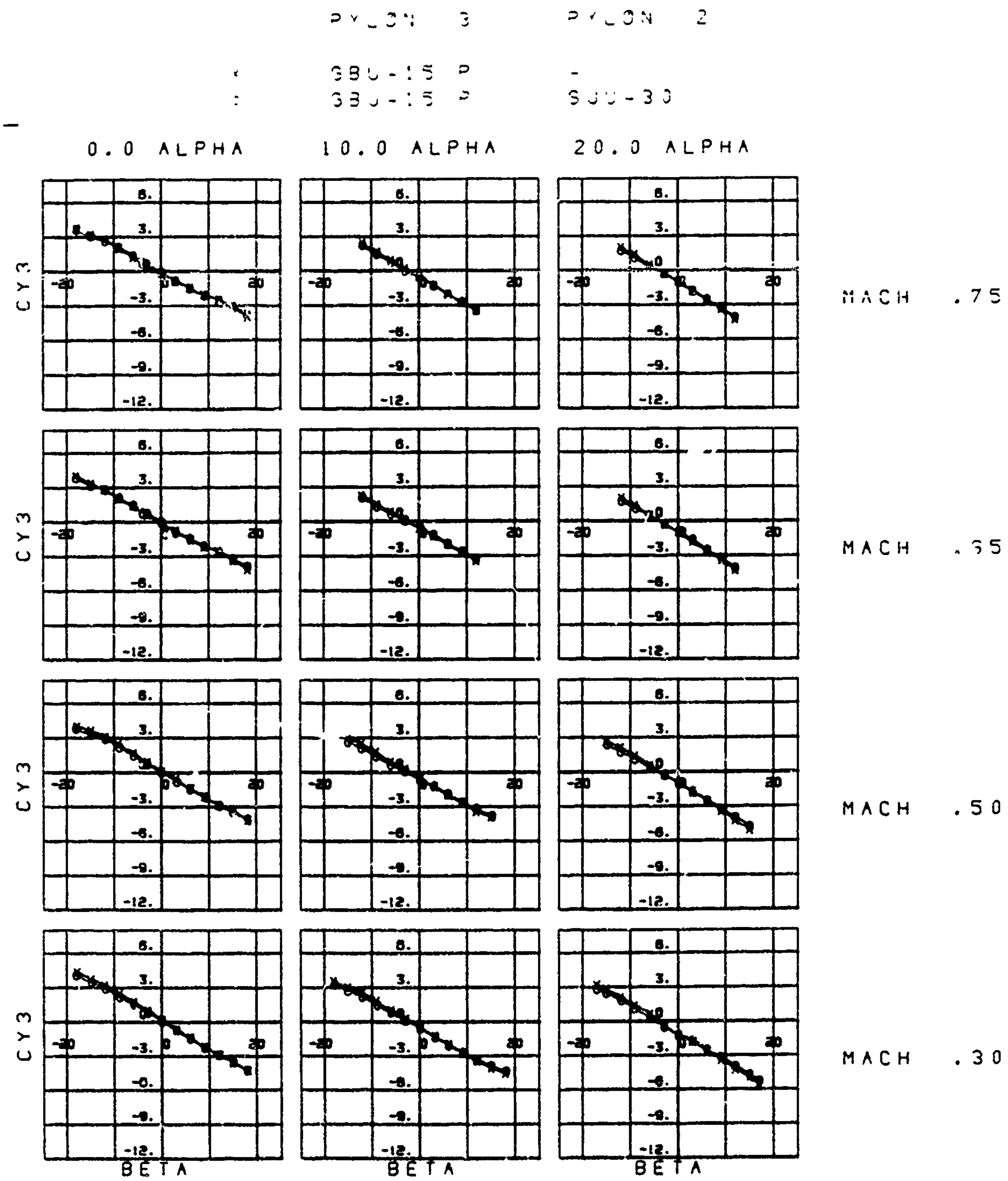


Figure 70. CY, Pylon 3 Versus Pylon 2, Cases 19, 29

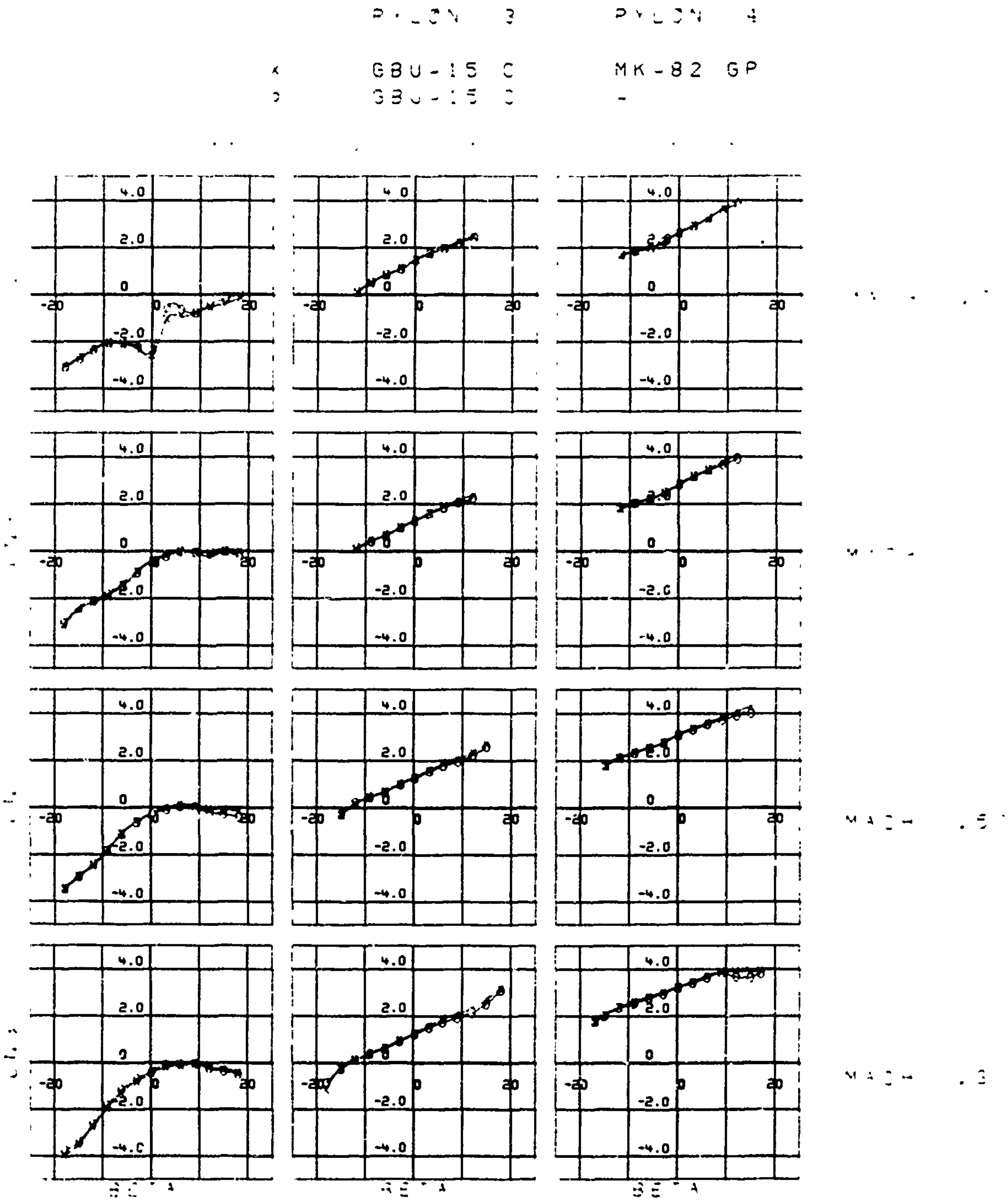


Figure 71. CN, Pylon 3 Versus Pylon 4, Cases 18, 30

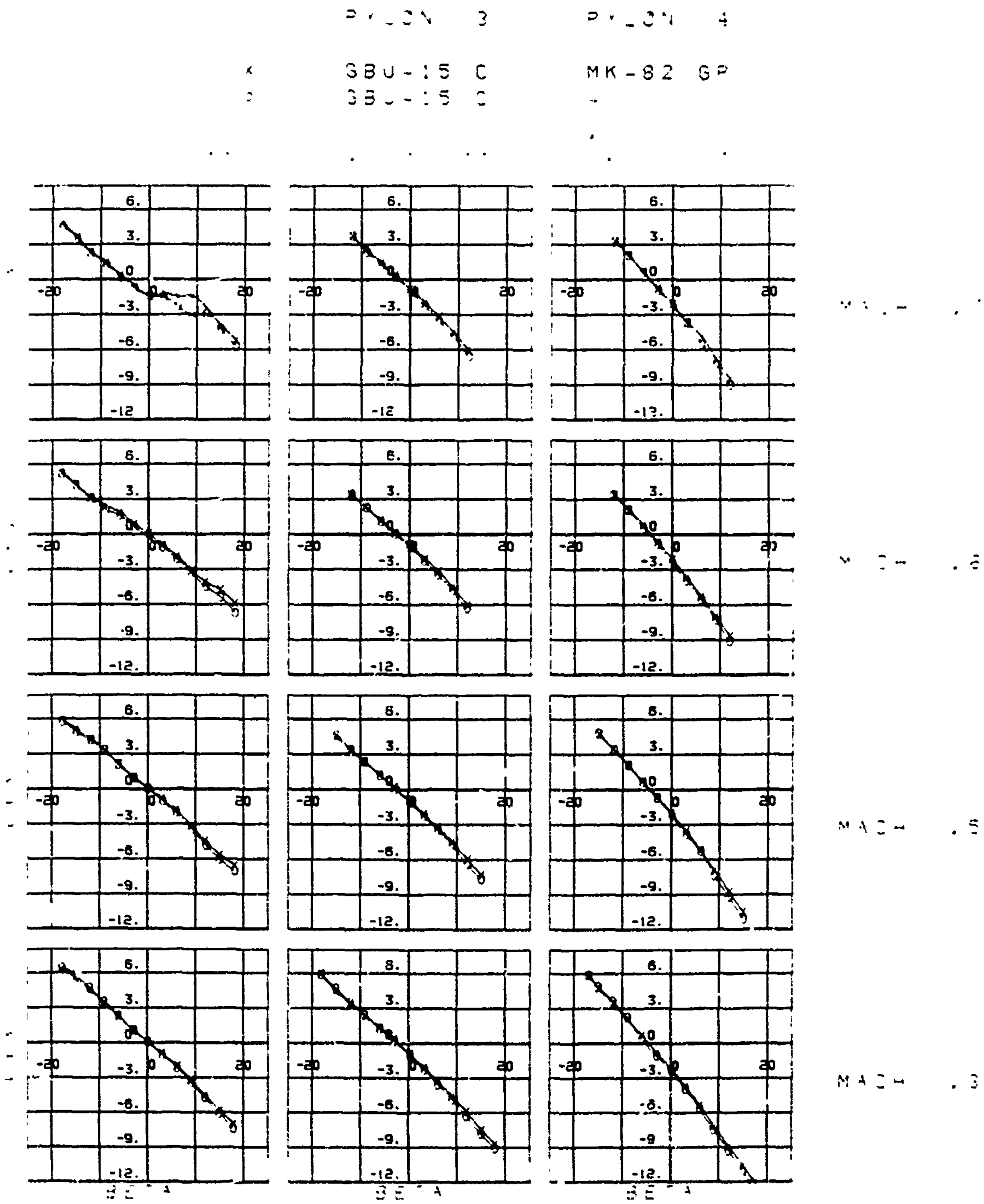


Figure 72. CY, Pylon 3 Versus Pylon 4, Cases 18, 30

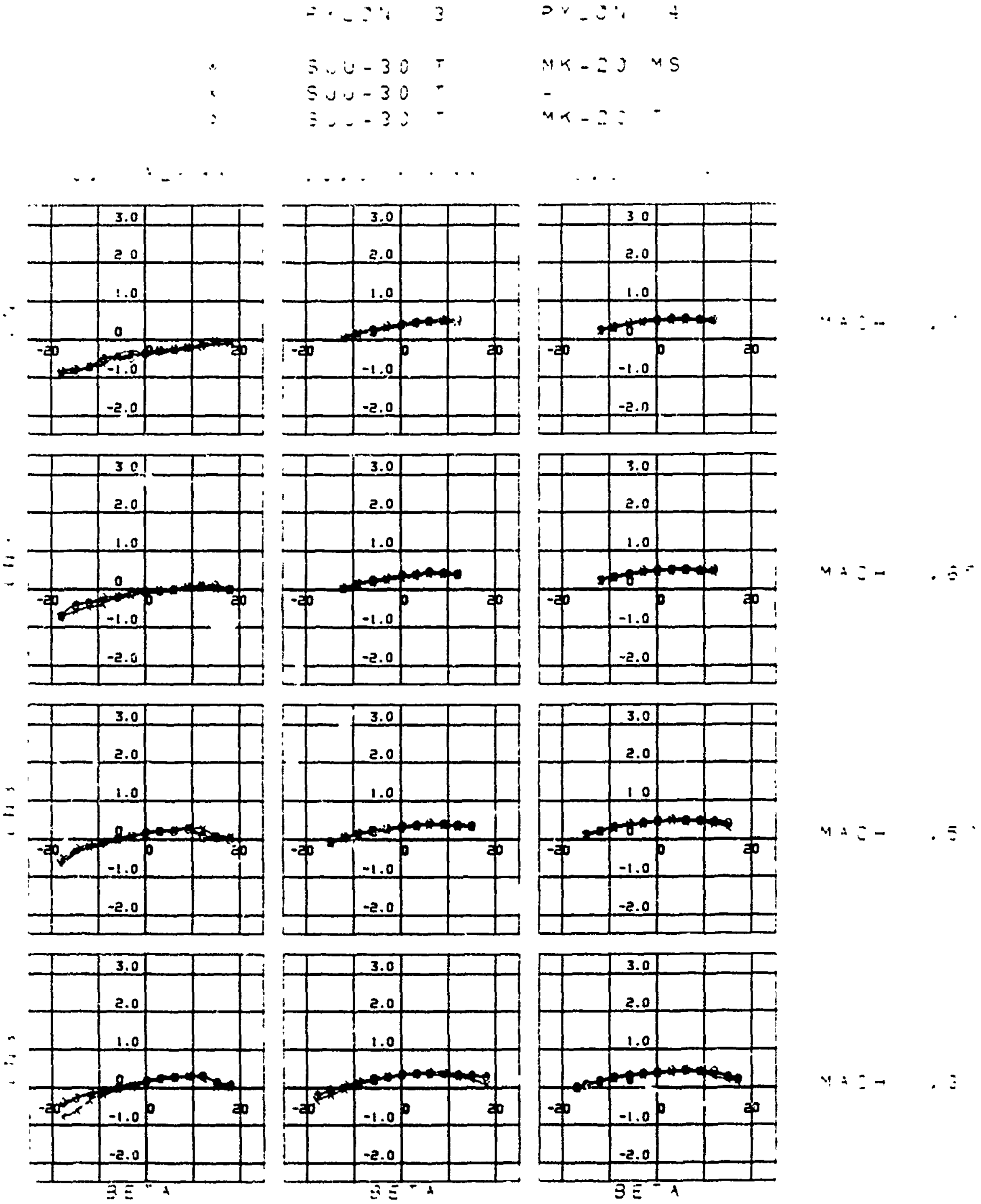


Figure 73, CN, Pylon 3 Versus Pylon 4, Cases 20, 31, 32

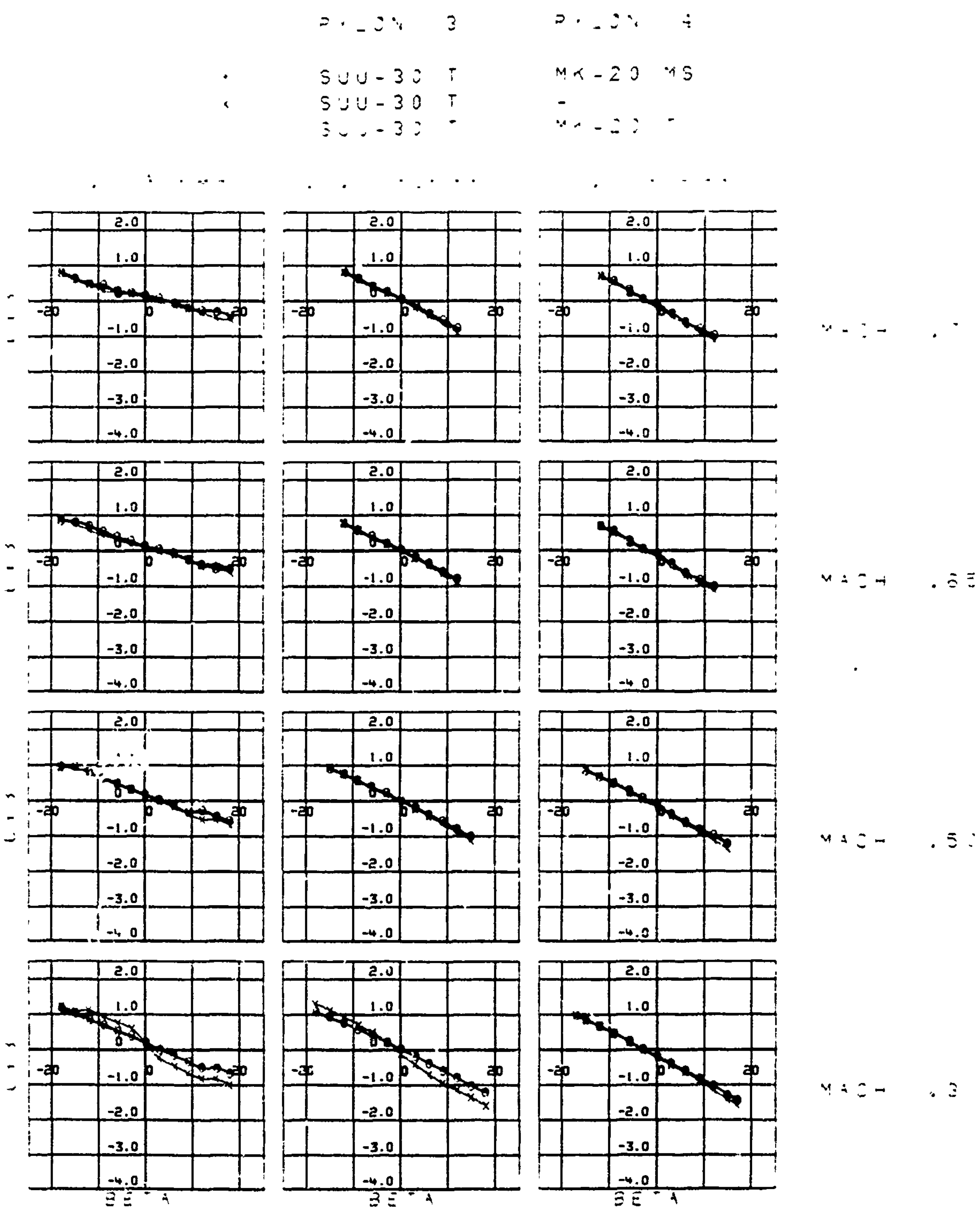


Figure 74 CY, Pylon 3 Versus Pylon 4, Cases 20, 31, 32

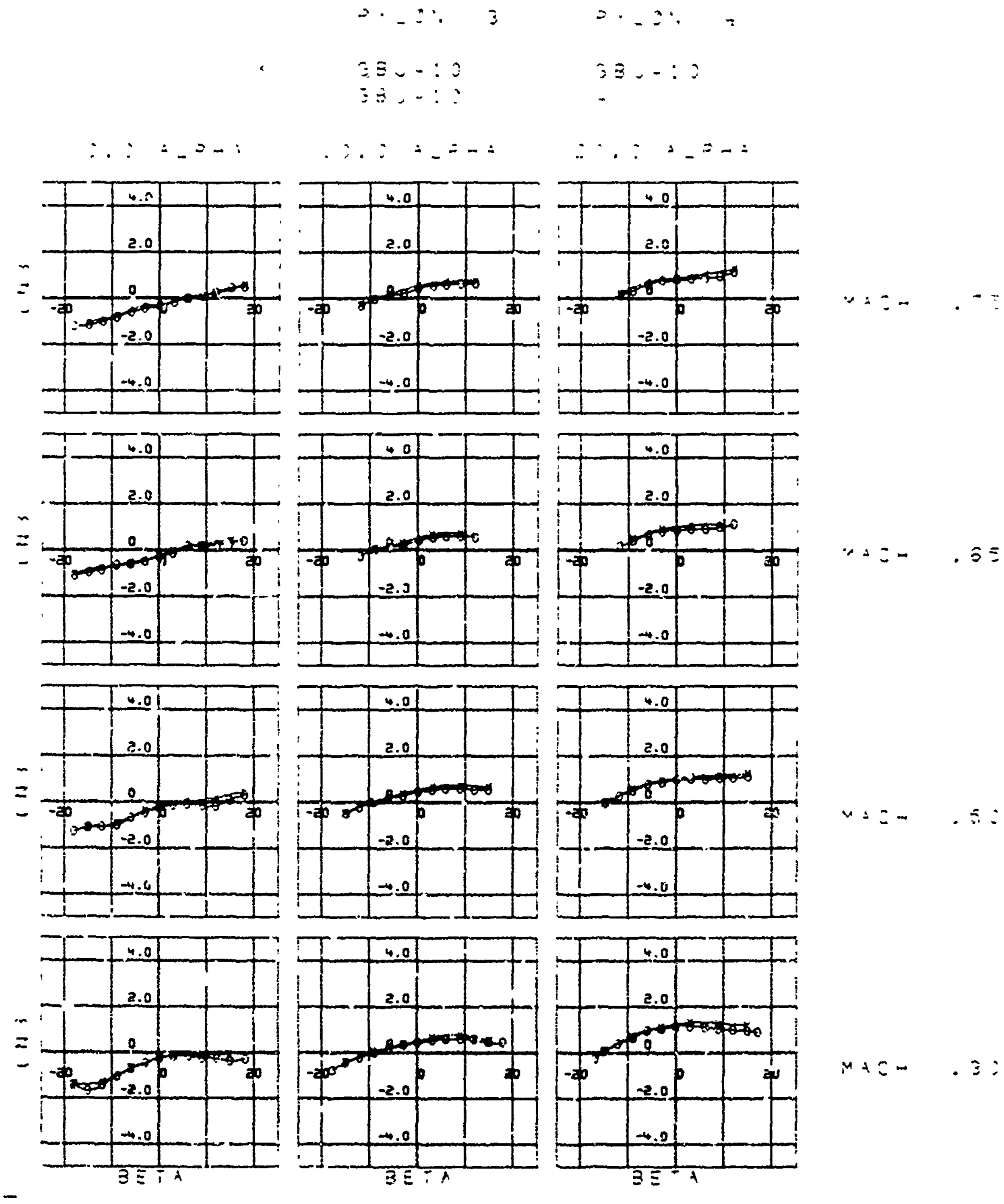


Figure 75. CN, Pylon 3 Versus Pylon 4, Cases 17, 33

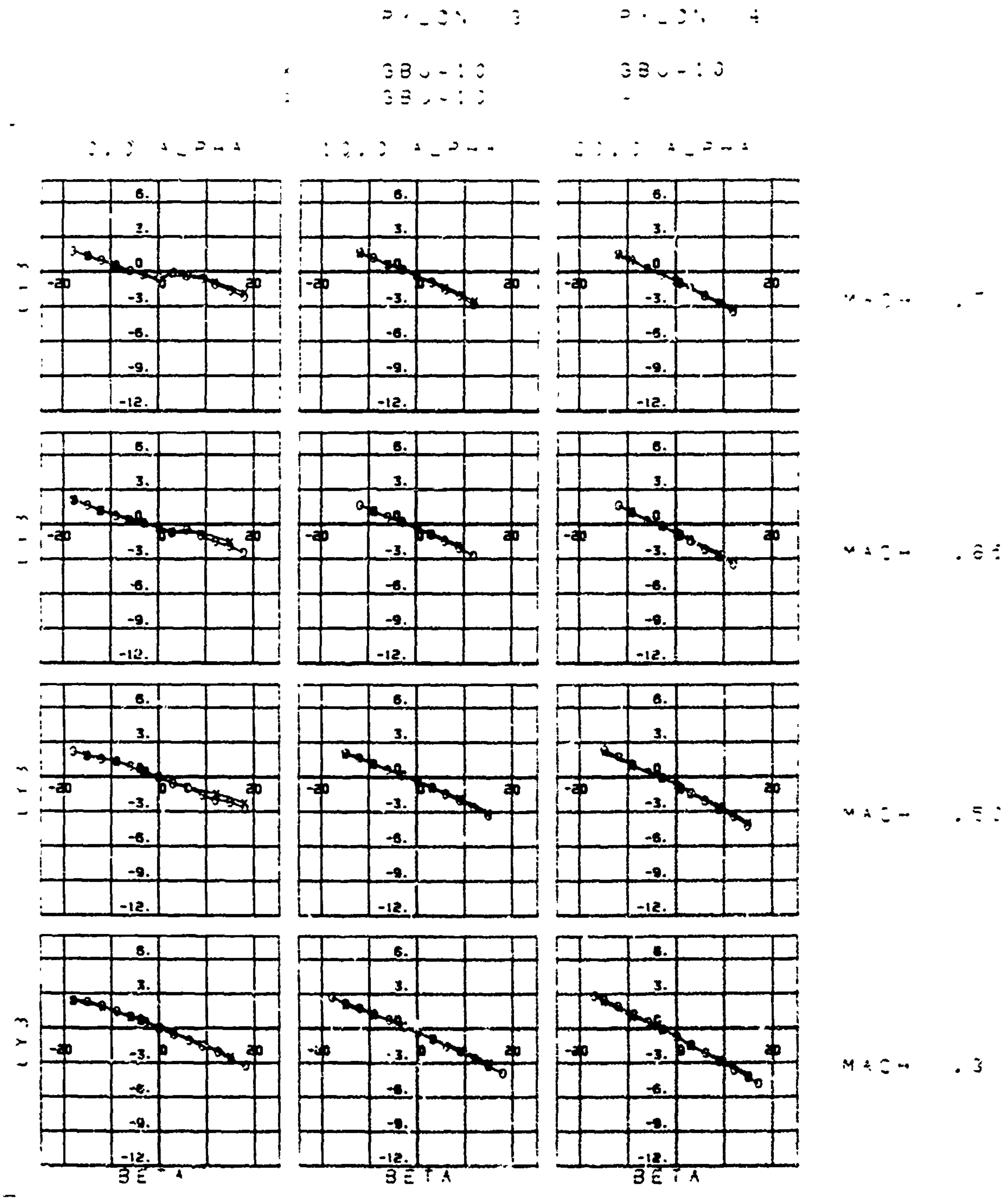


Figure 76. CY, Pylon 3 Versus Pylon 4, Cases 17, 33

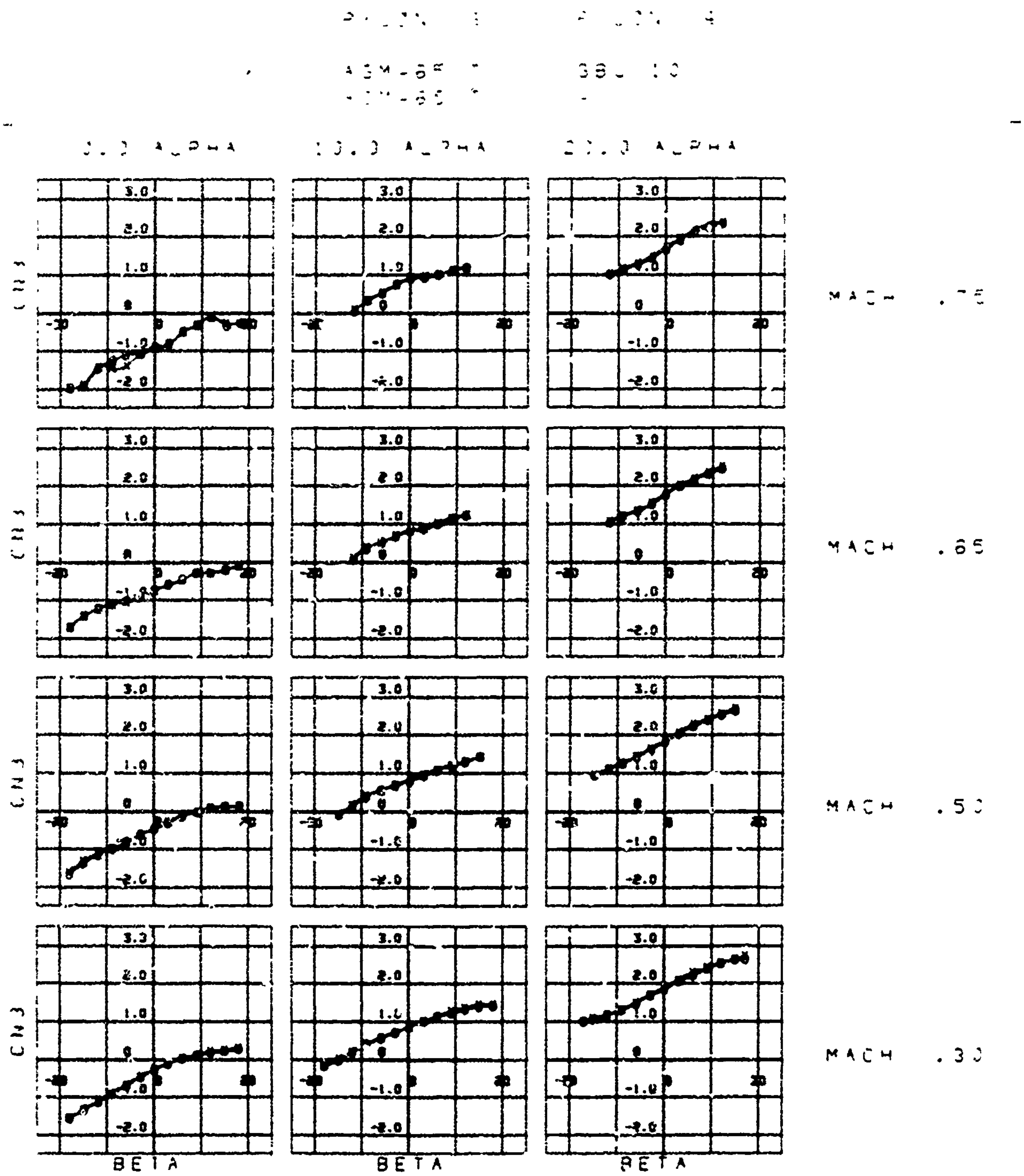


Figure 77. CN, Pylon 3 Versus Pylon 4, Cases 21, 34

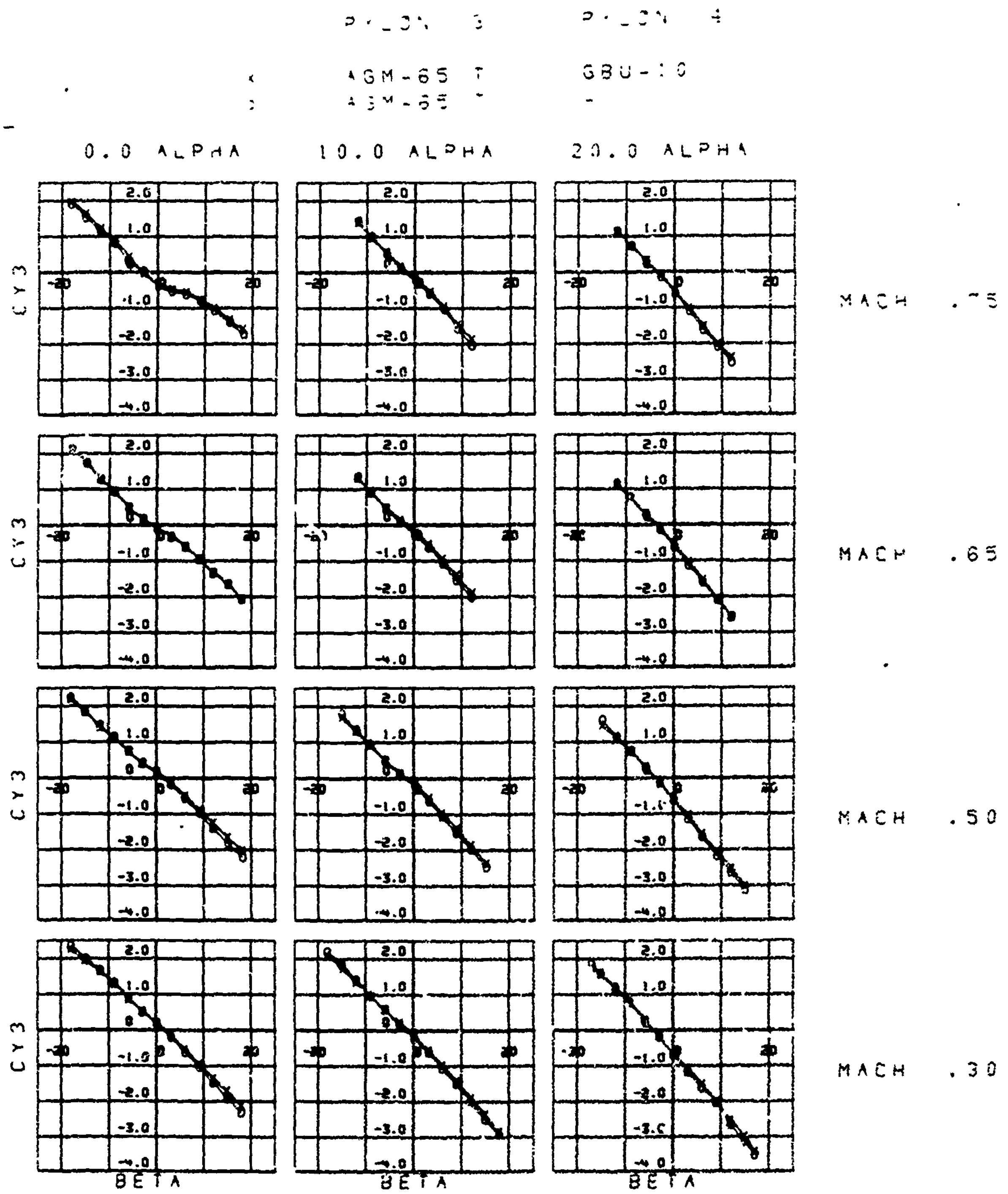


Figure 78. CY, Pylon 3 Versus Pylon 4, Cases 21, 34

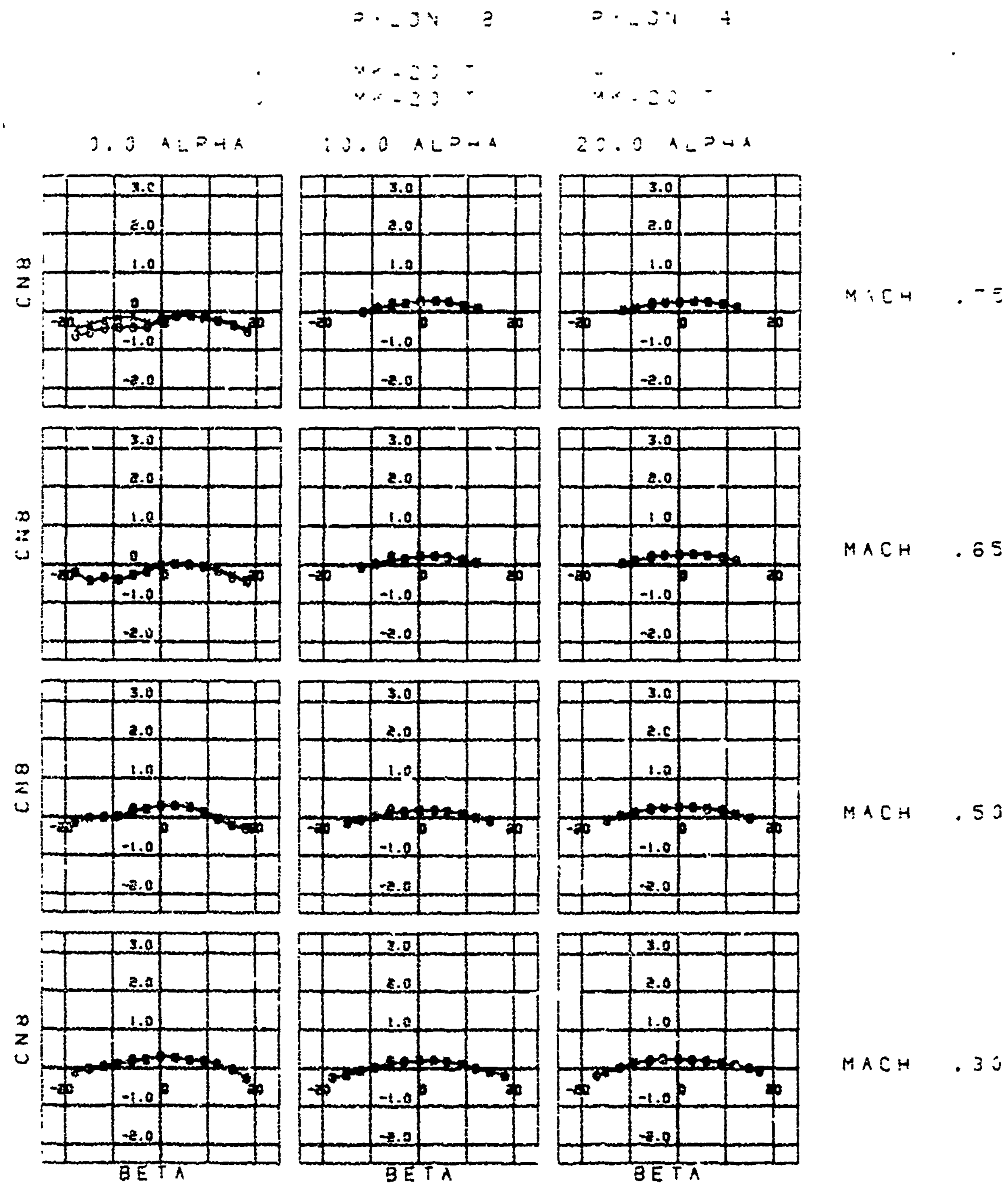


Figure 79. CN, Pylon 8 Versus Pylon 4, Cases 50, 53

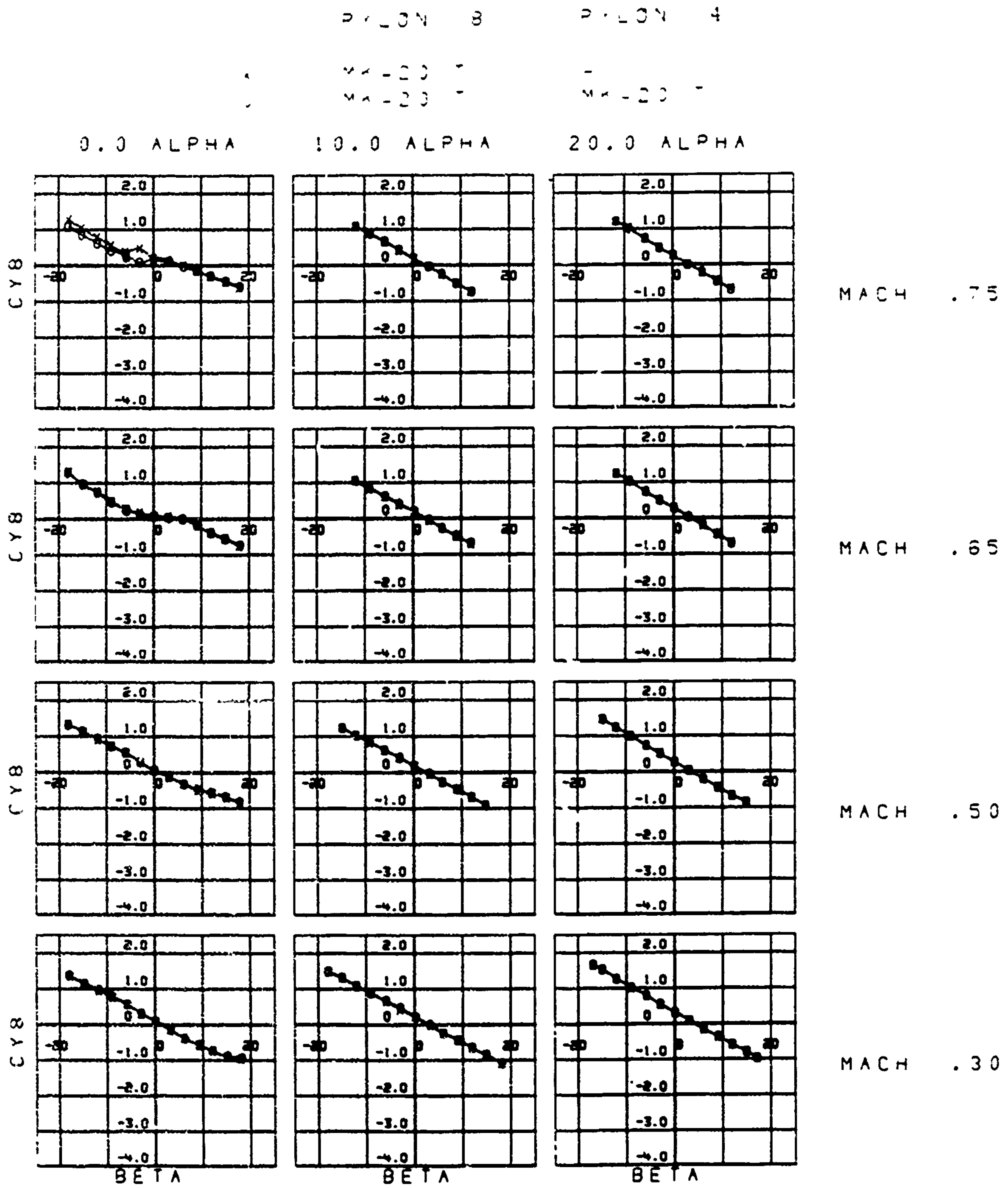


Figure 80. CY, Pylon 8 Versus Pylon 4, Cases 50, 53

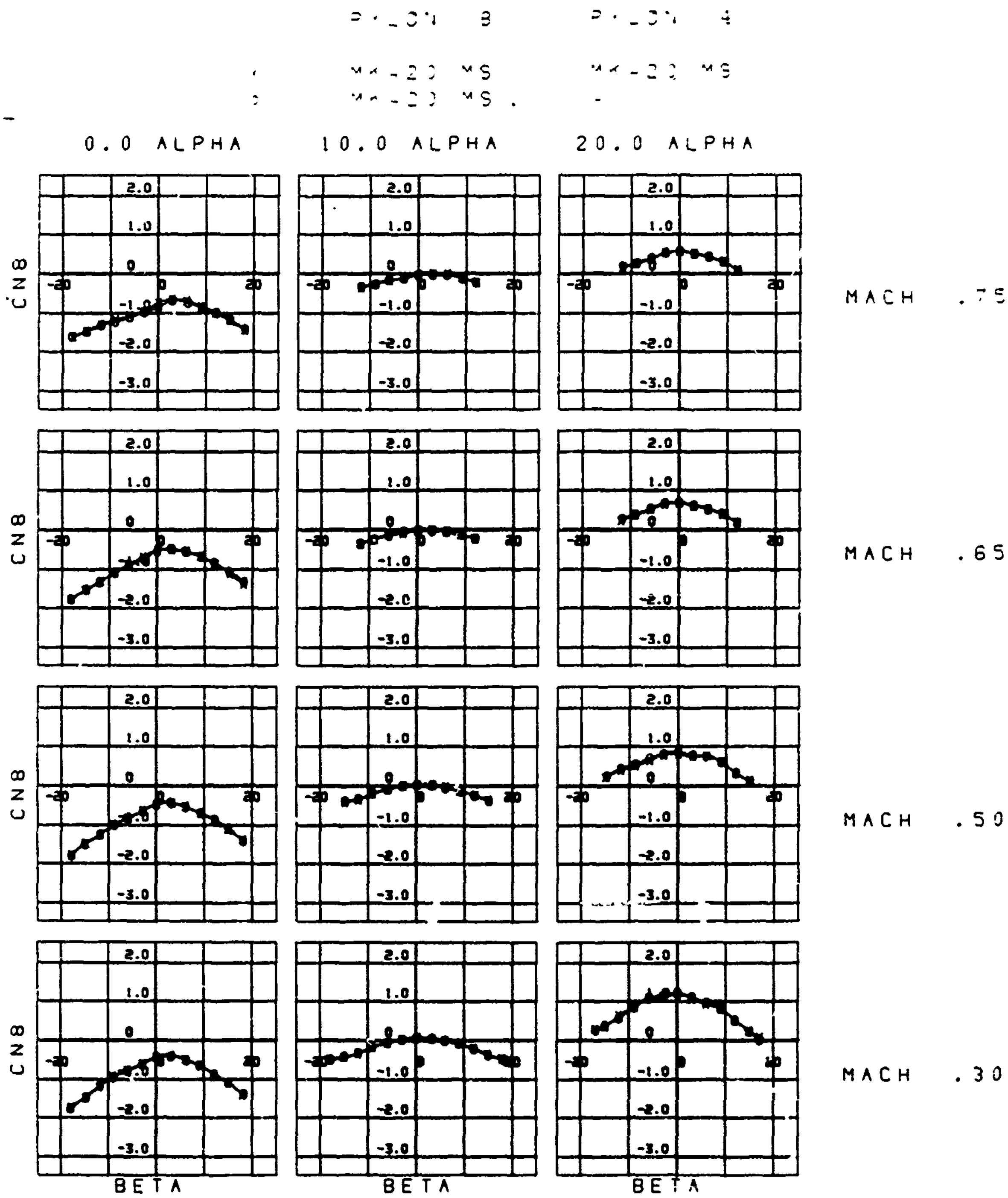


Figure 81. CN, Pylon 8 Versus Pylon 4, Cases 51, 52

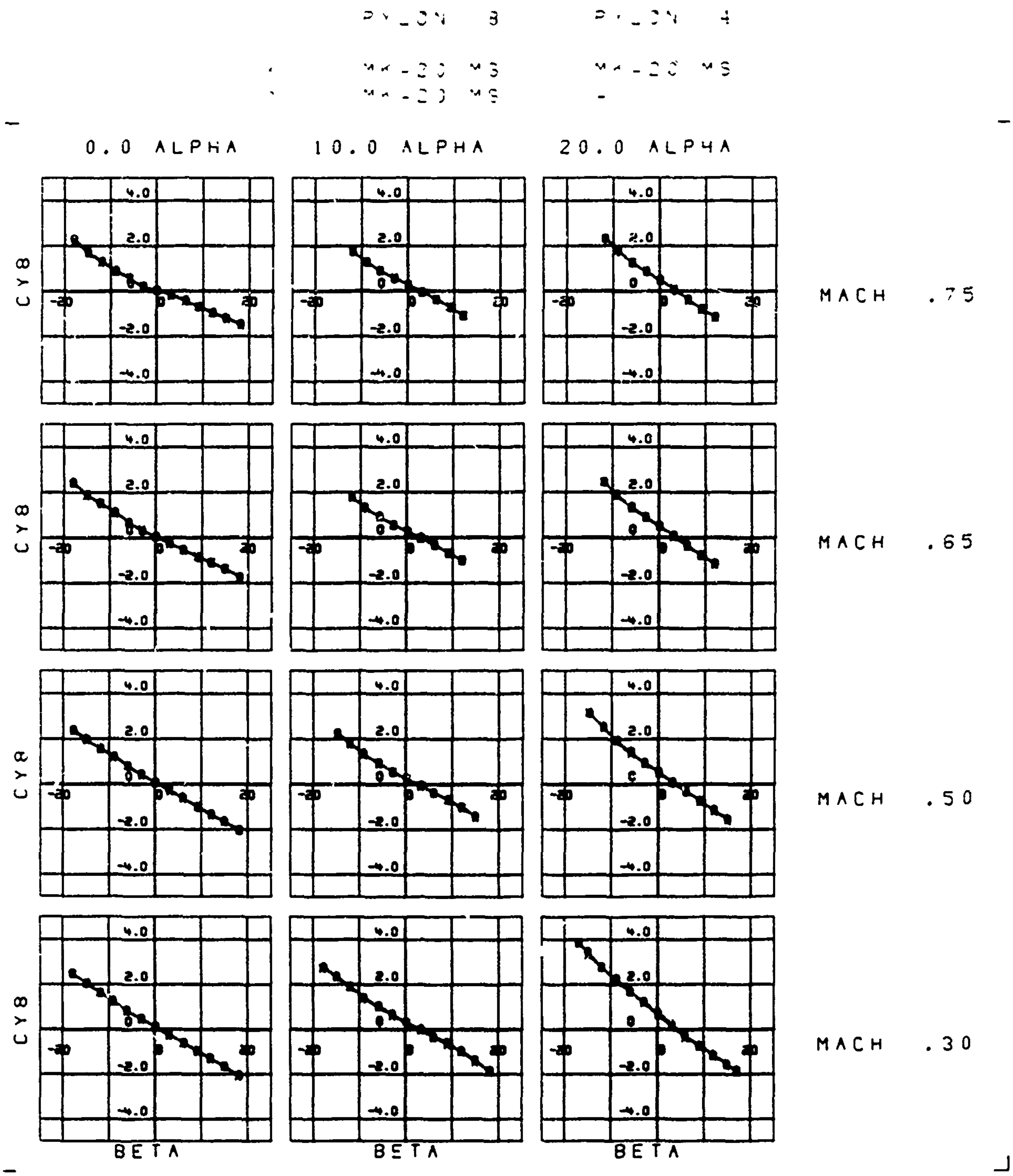


Figure 82. CY, Pylon 3 Versus Pylon 4, Cases 51, 52

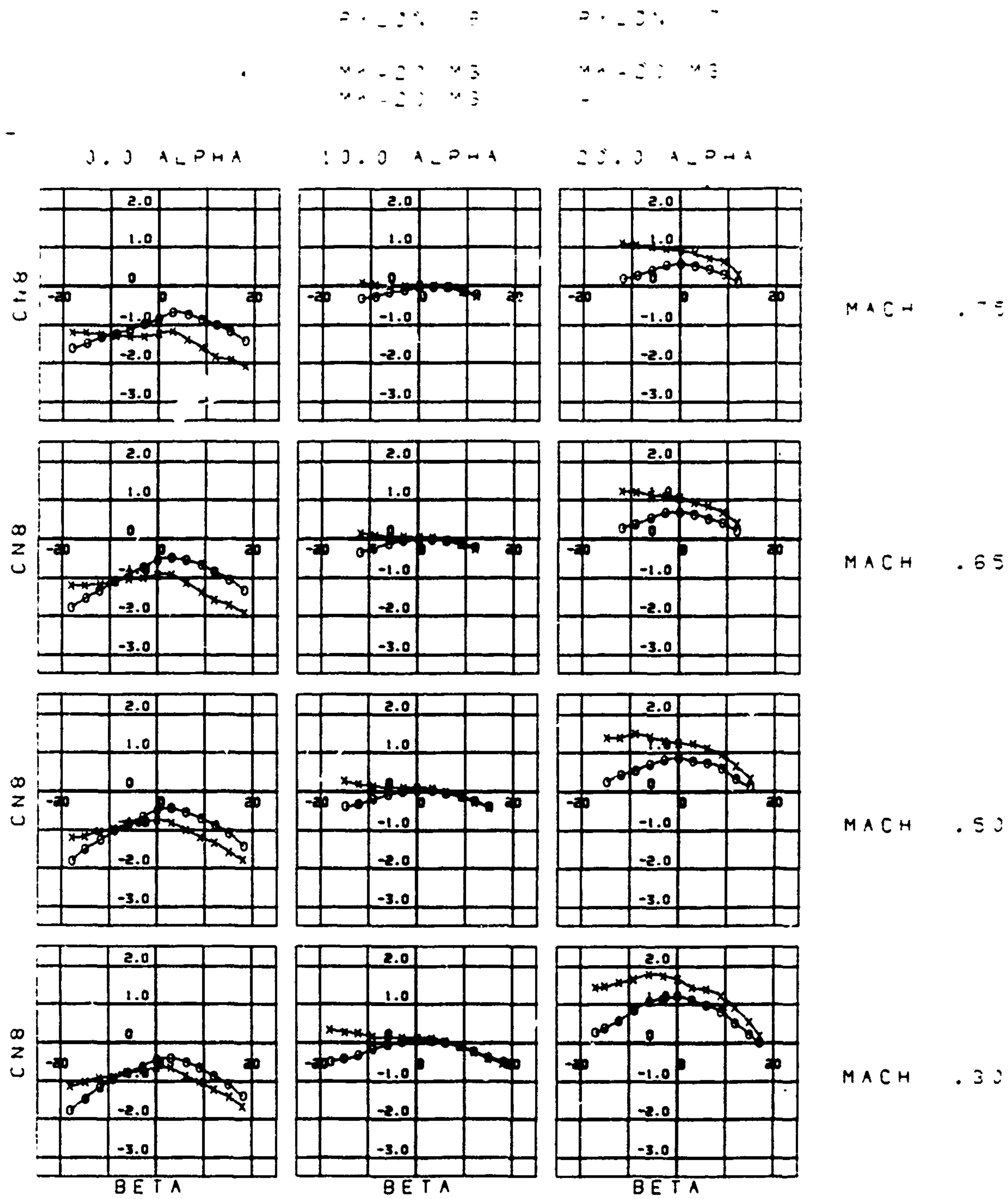


Figure 83. CN, Pylon 8 Versus Pylon 7, Cases 51, 54

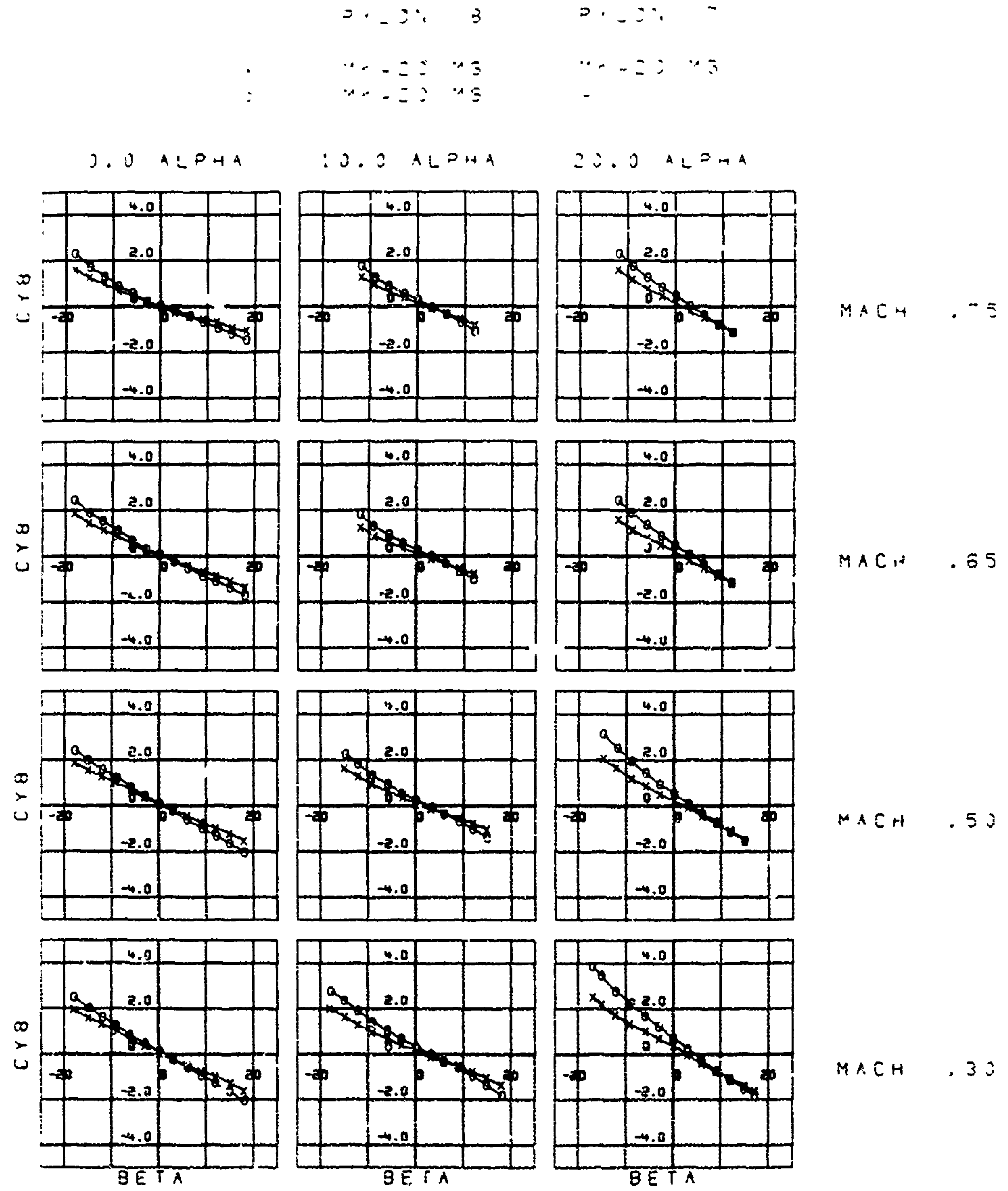


Figure 84. CY, Pylon 8 Versus Pylon 7, Cases 51, 54

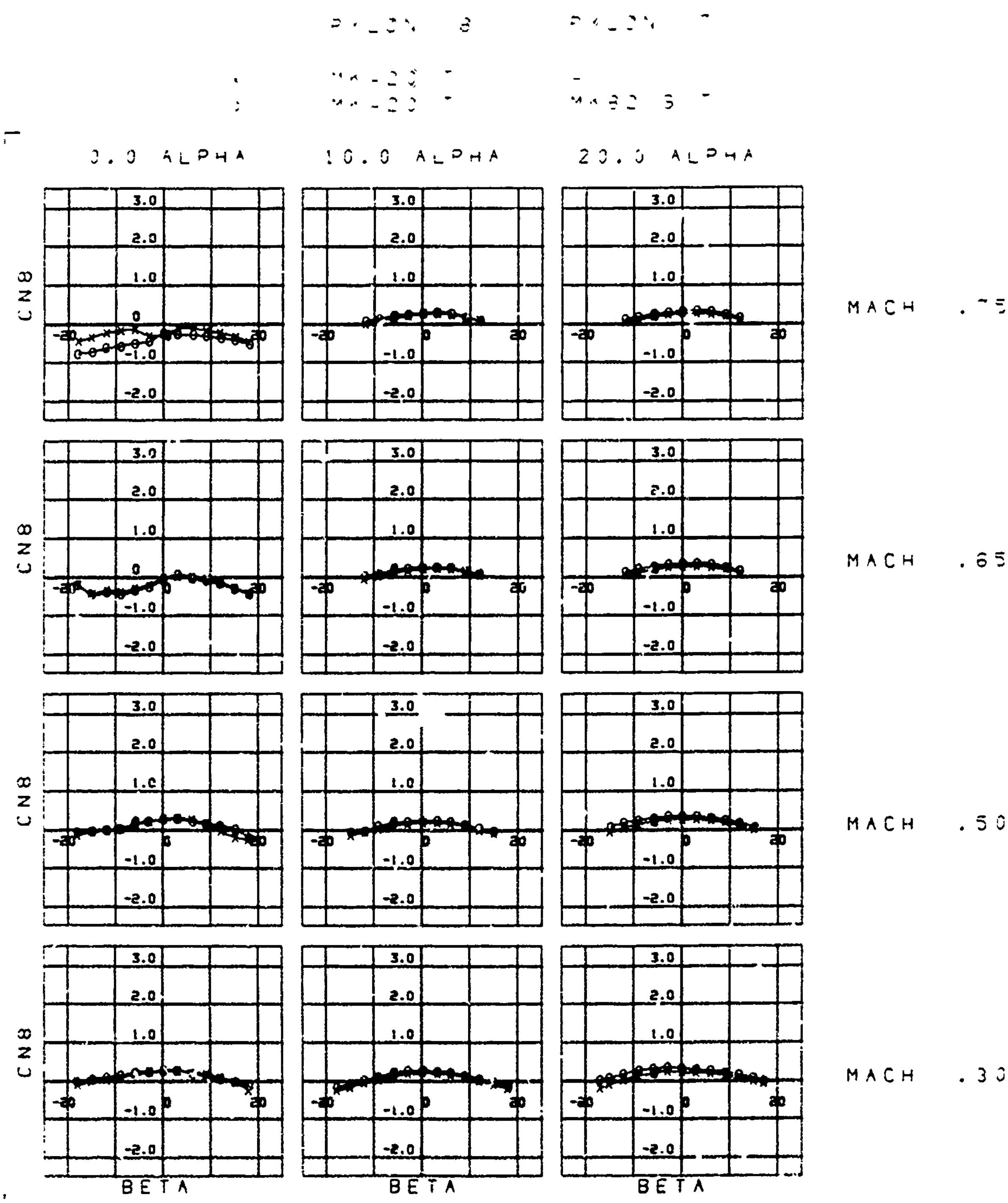


Figure 85. CN, Pylon 8 Versus Pylon 7, Cases 50, 55

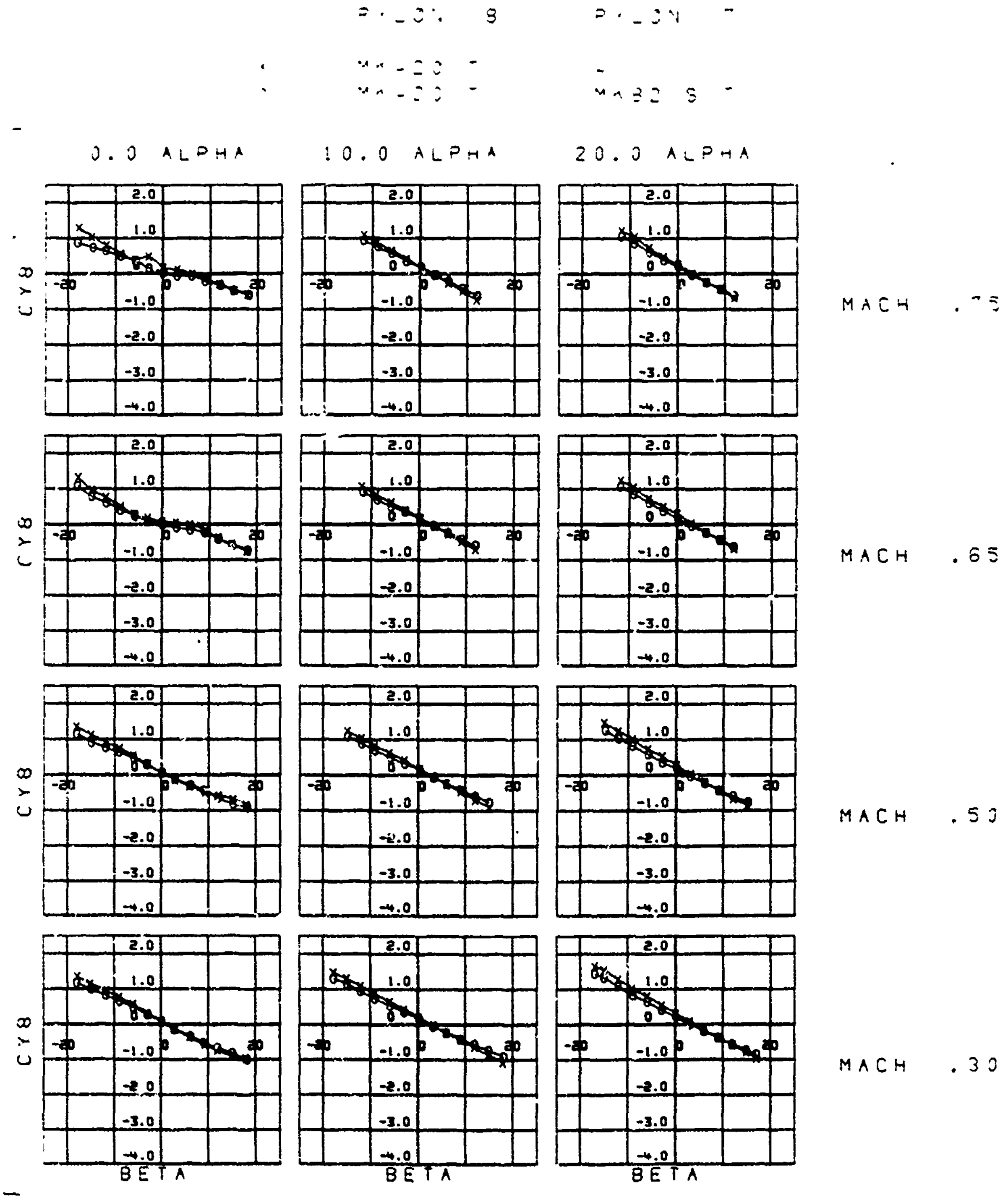


Figure 86. CY, Pylon 8 Versus Pylon 7, Cases 50, 55

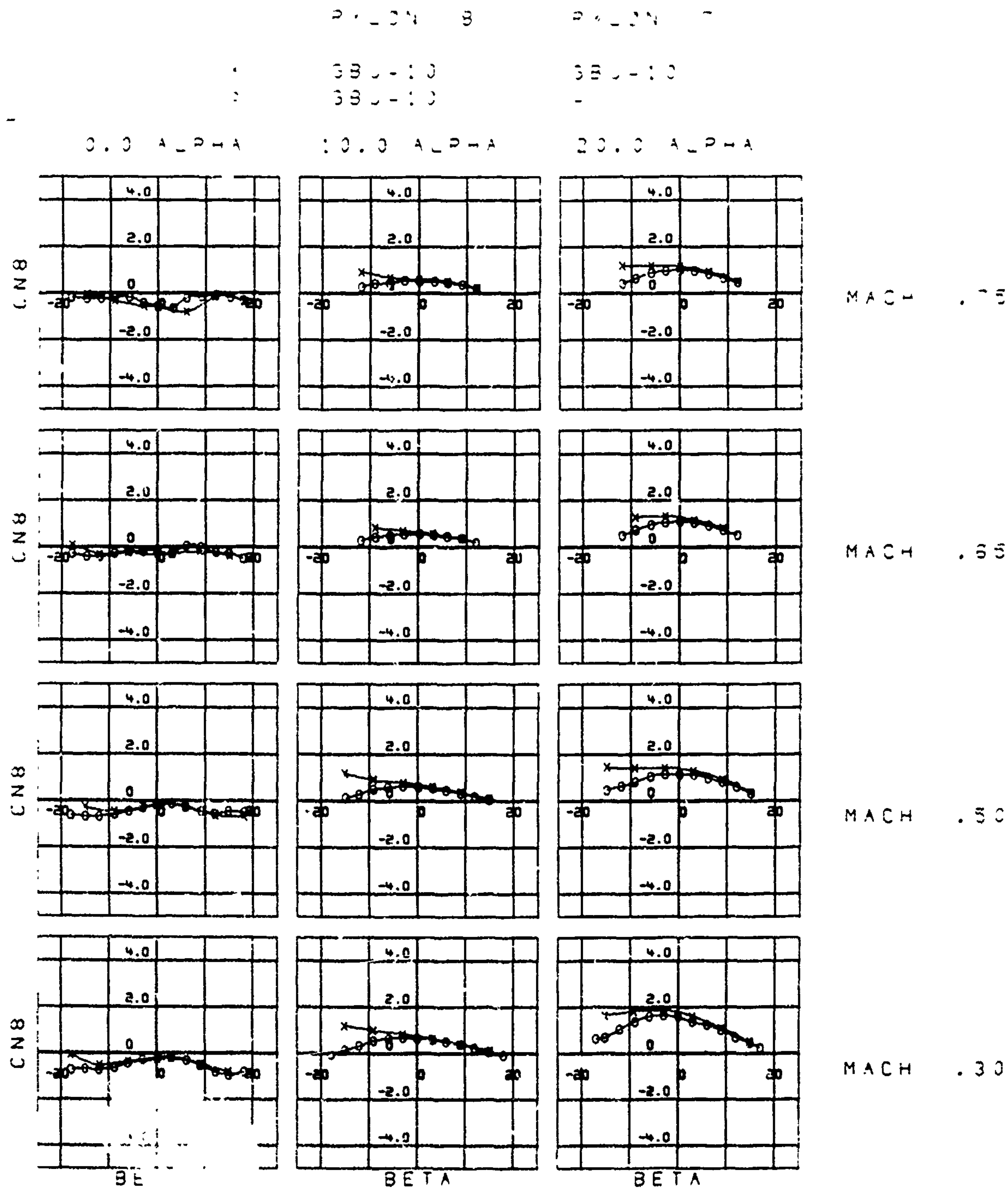


Figure 87. CN, Pylon 8 Versus Pylon 7, Cases 49, 56

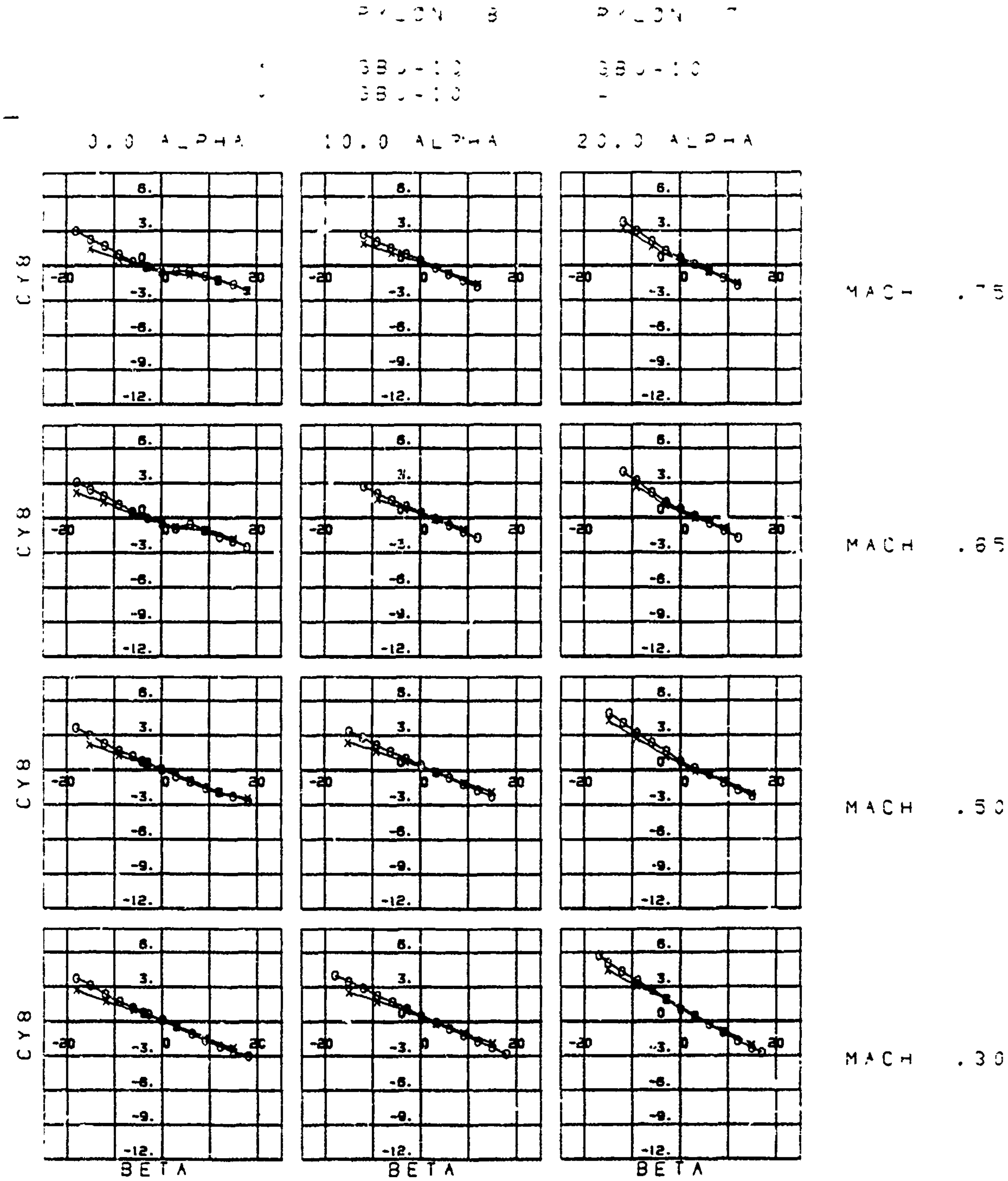


Figure 88. CY, Pylon 8 Versus Pylon 7, Cases 49, 56

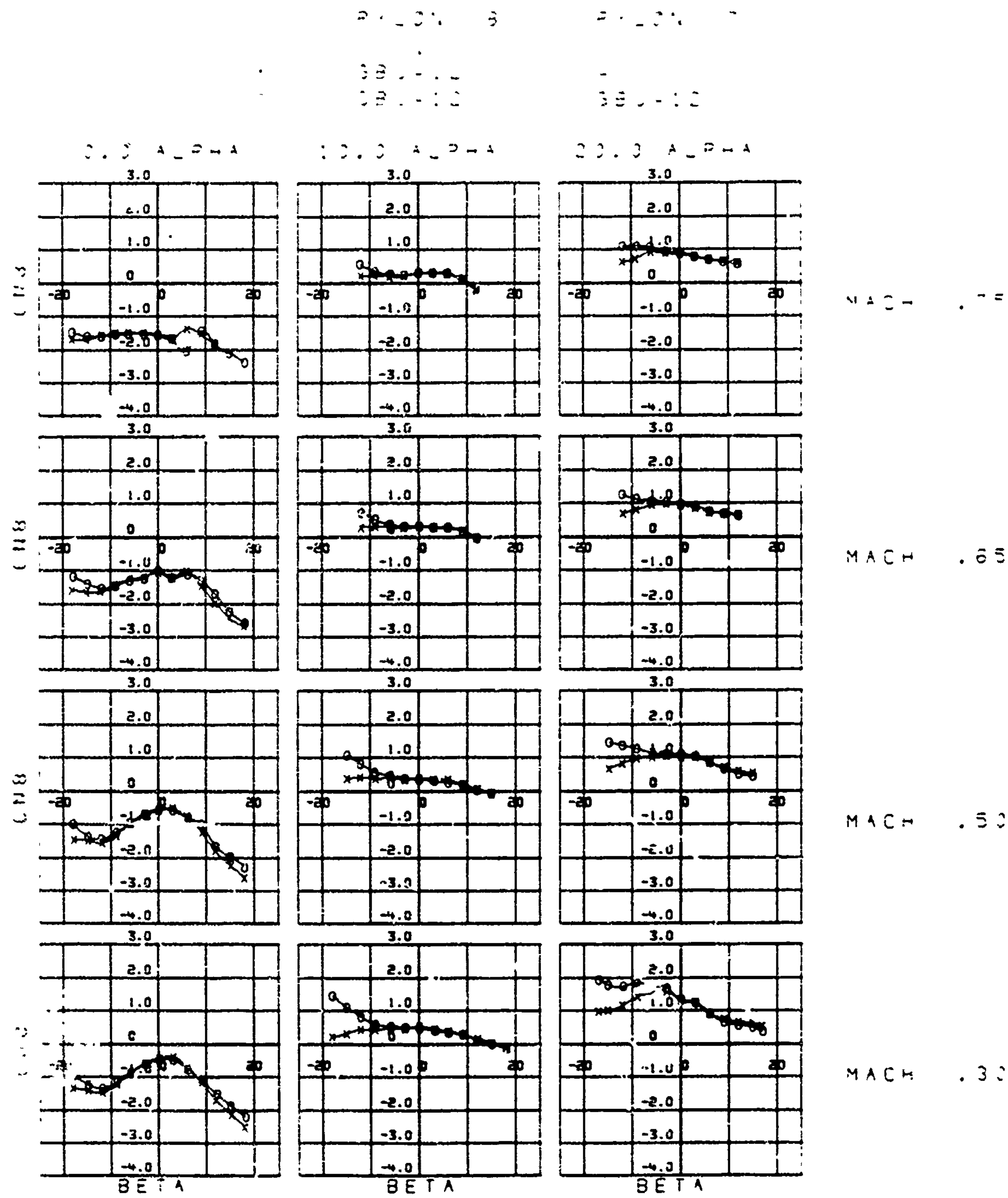


Figure 89. CN, Pylon 8 Versus Pylon 7, Cases 47, 57

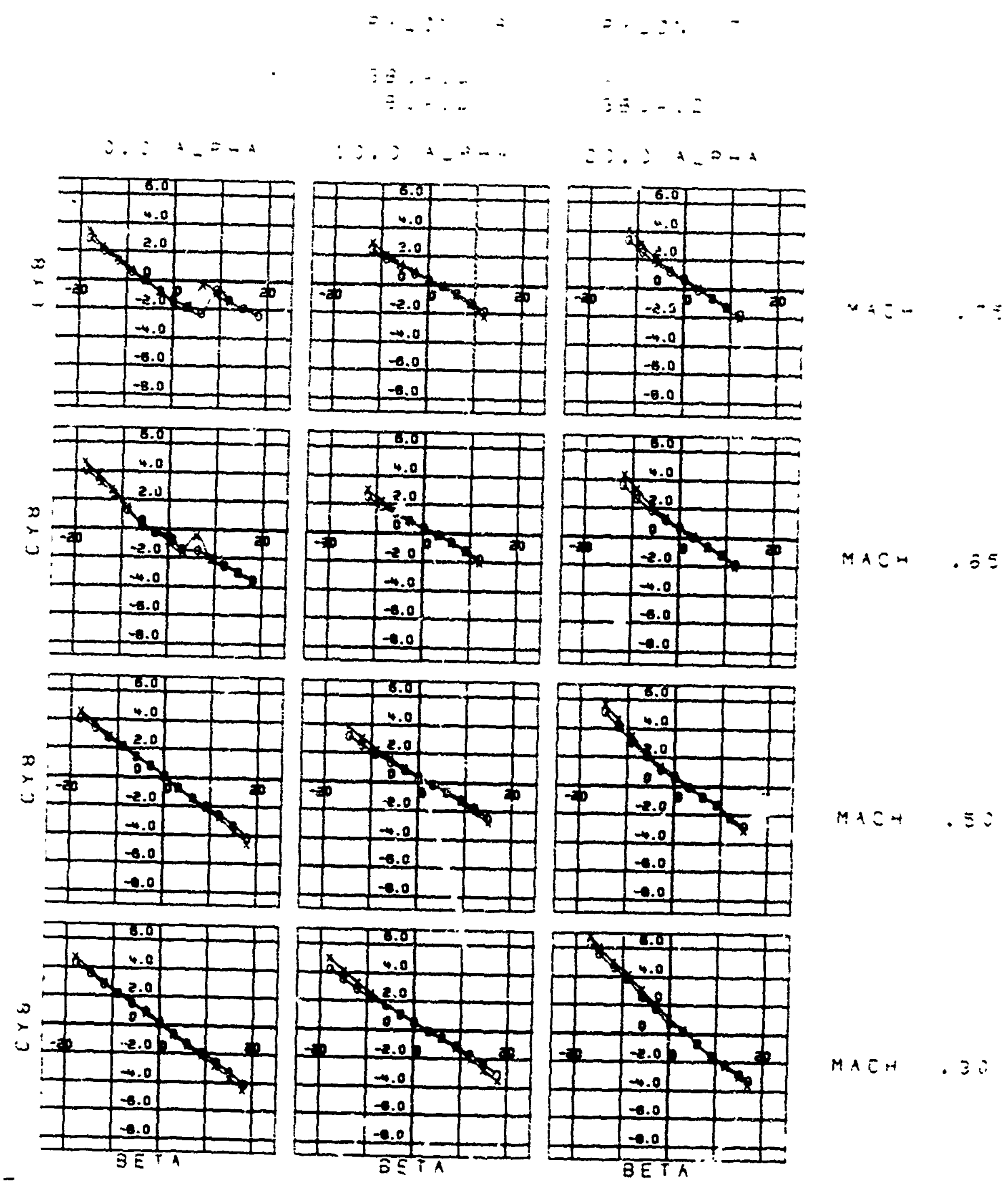


Figure 90. CY, Pylon 8 Versus Pylon 7, Cases 47, 57

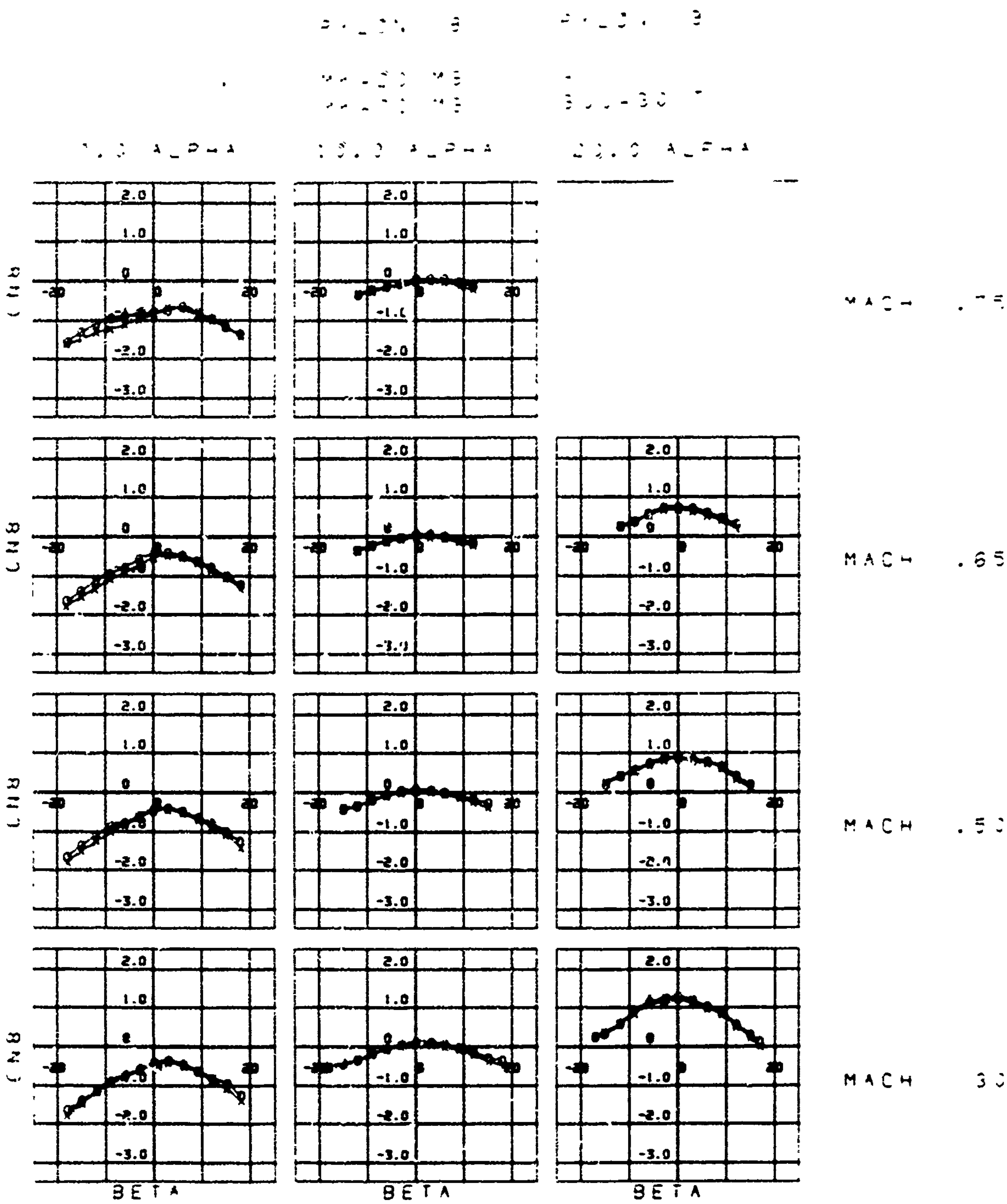


Figure 91. CN, Pylon 8 Versus Pylon 9, Cases 51, 58

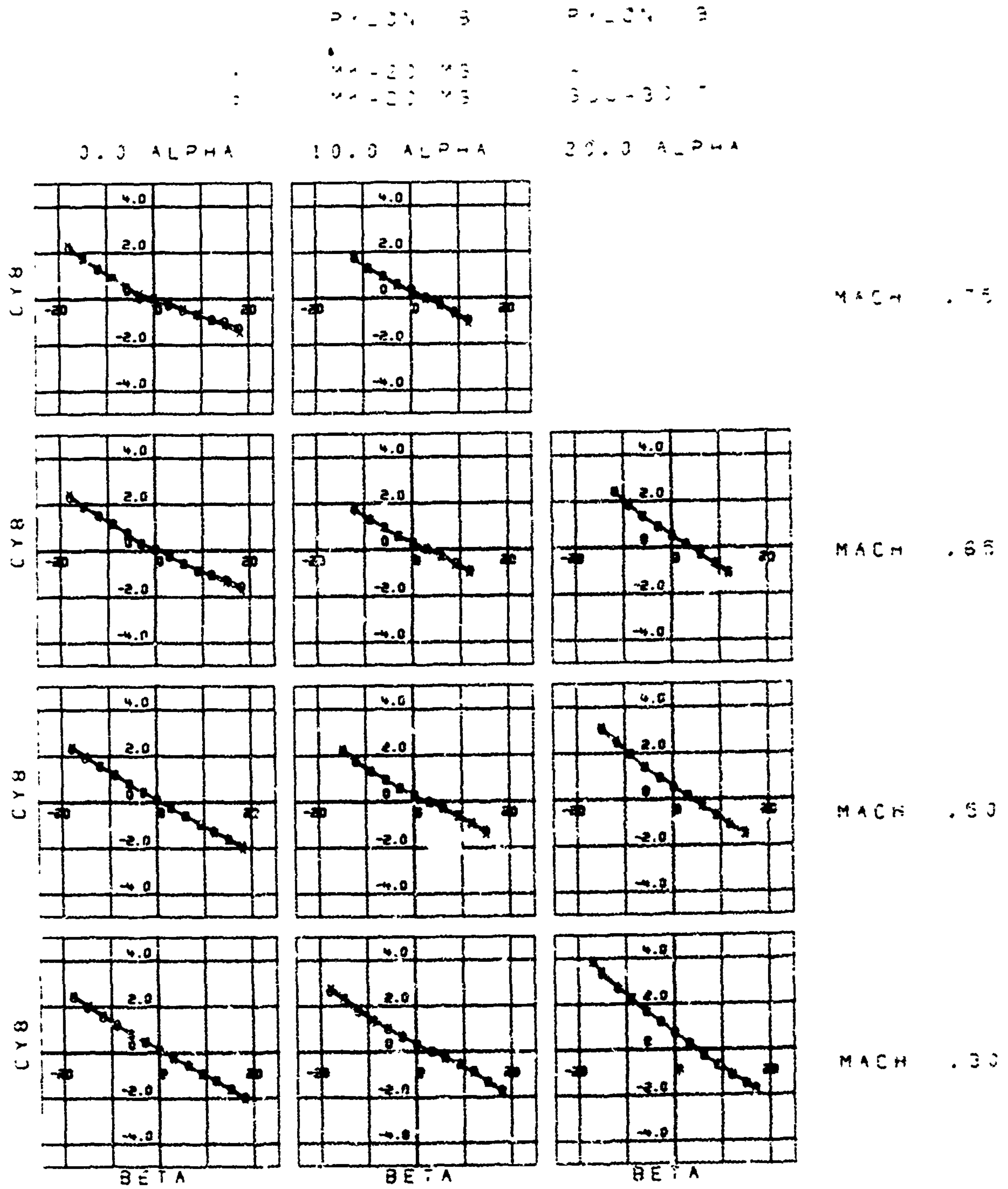


Figure 92. CY, Pylon 3 Versus Pylon 9, Cases 51, 58

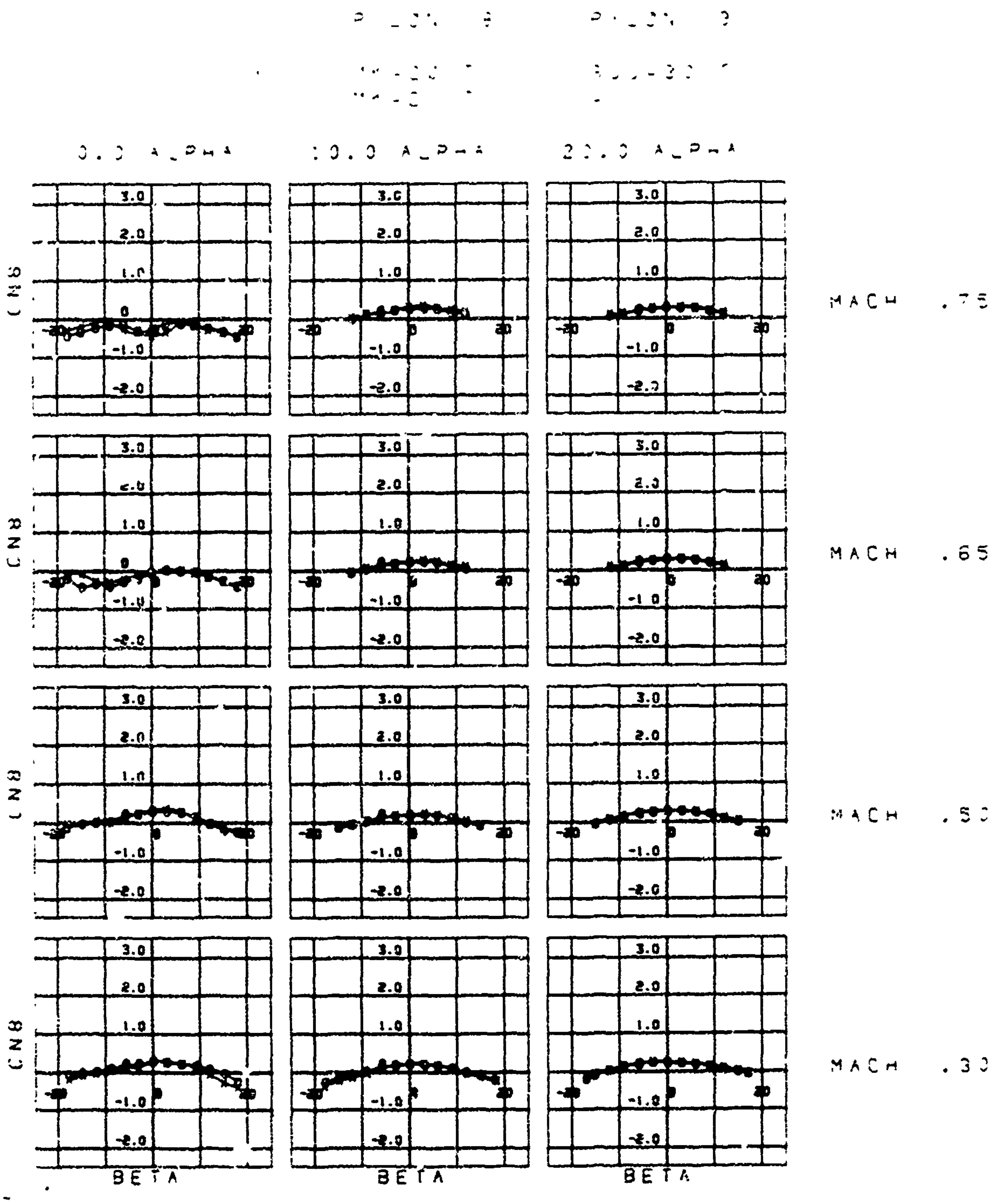


Figure 93. CN, Pylon 8 Versus Pylon 9, Cases 50, 59

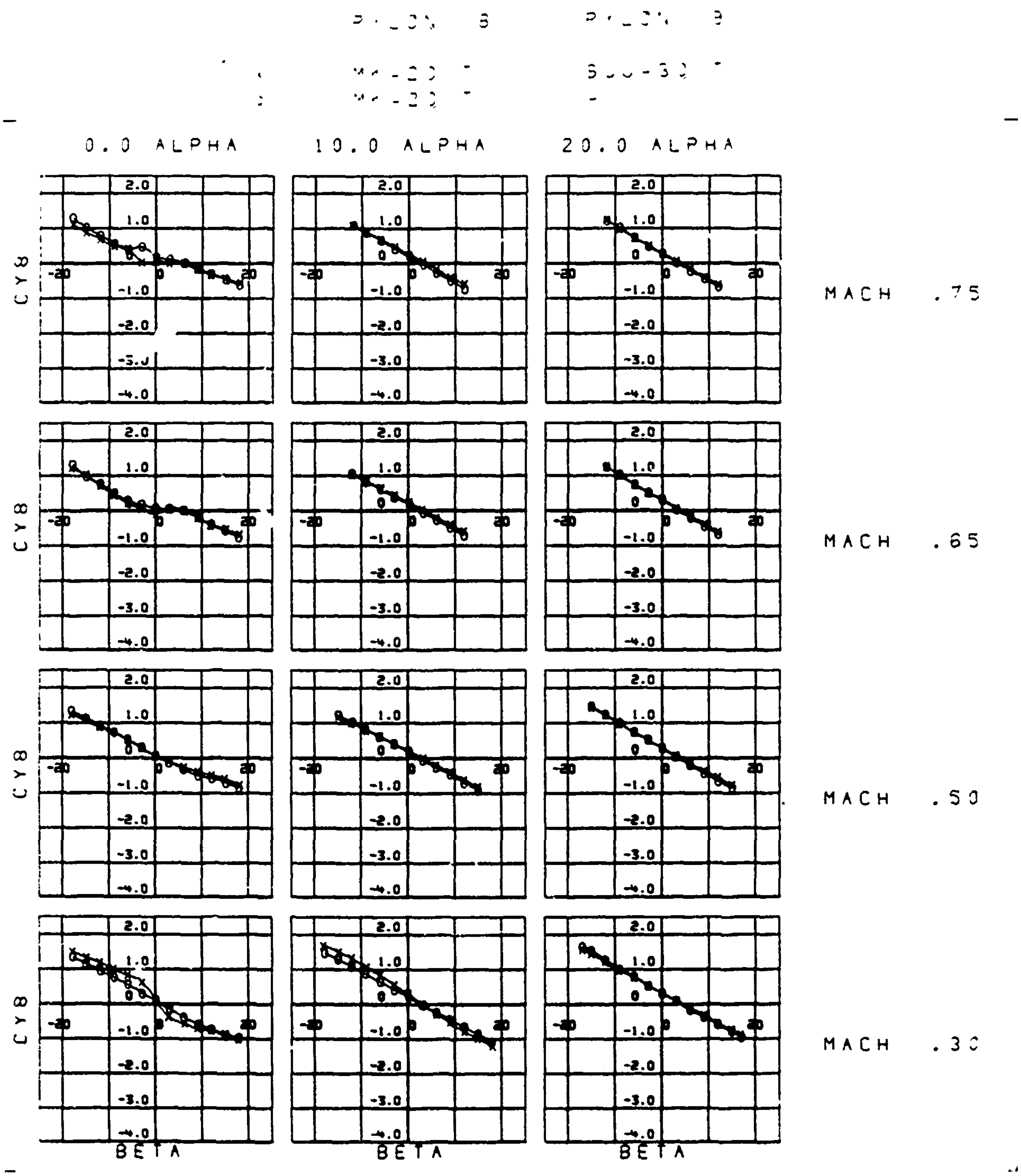


Figure 94. CY, Pylon 8 Versus Pylon 9, Cases 50, 59

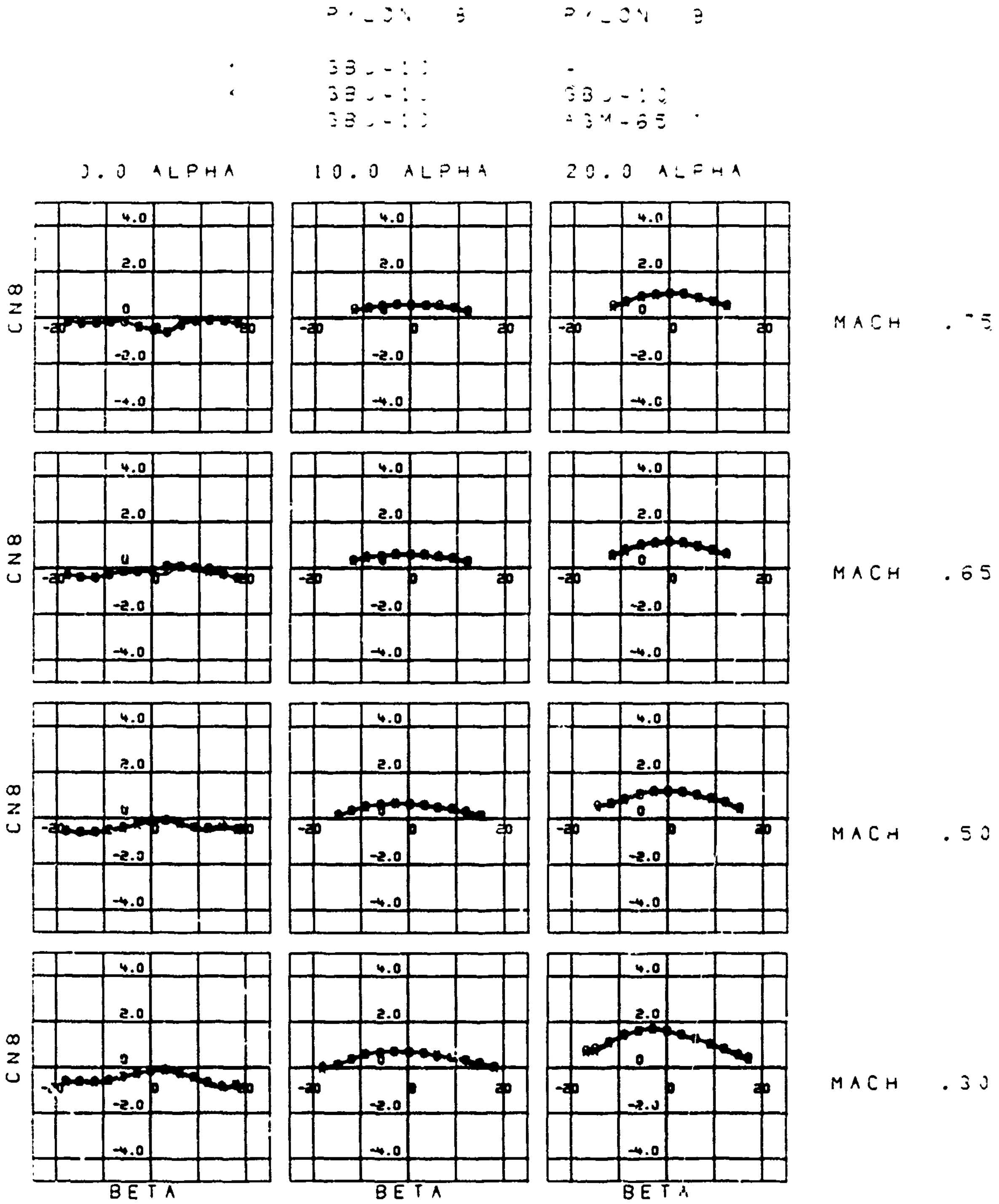


Figure 95. CN, Pylon 8 Versus Pylon 9, Cases 49, 60, 51

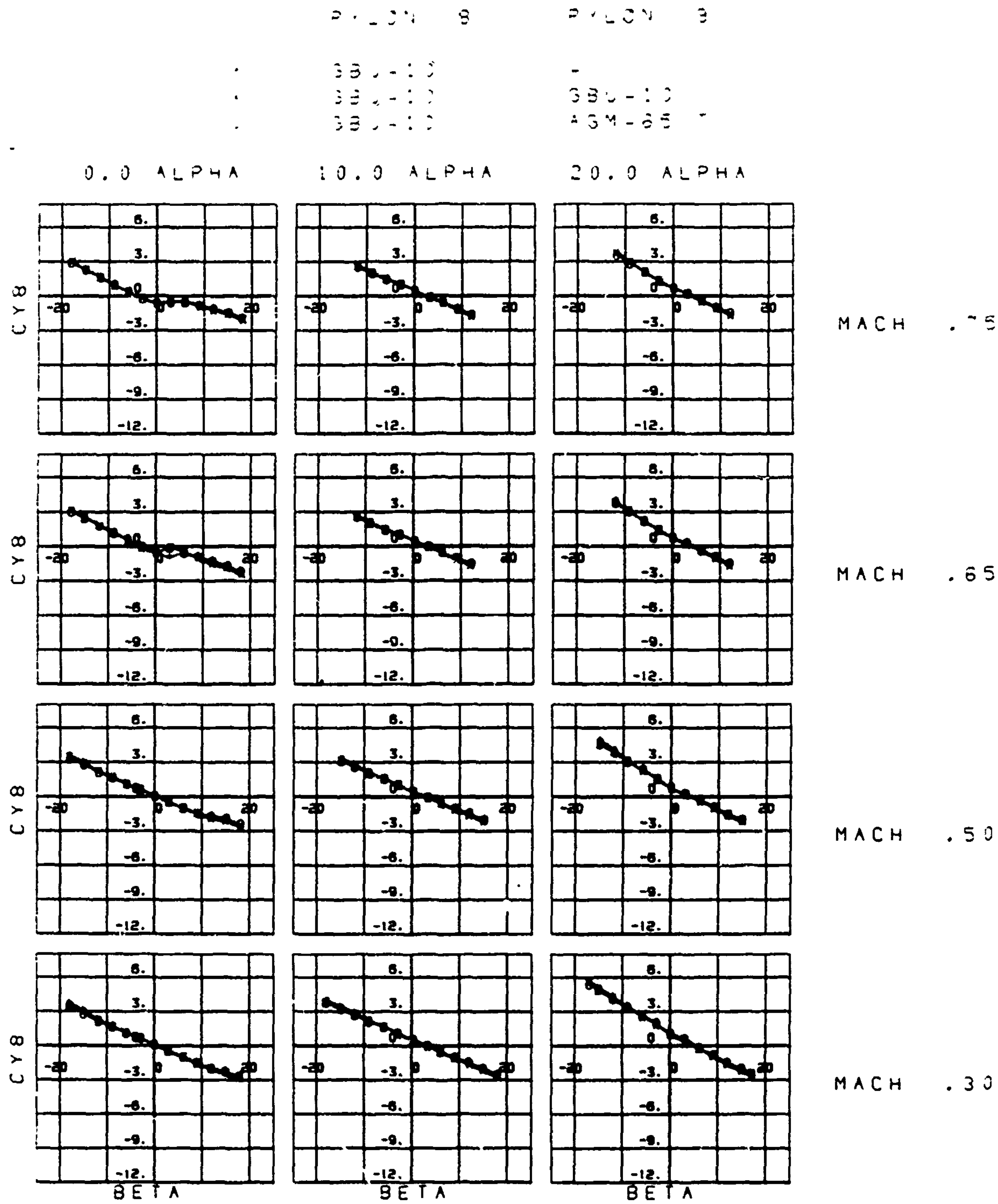


Figure 96. CY, Pylon 8 Versus Pylon 9, Cases 49, 60, 61

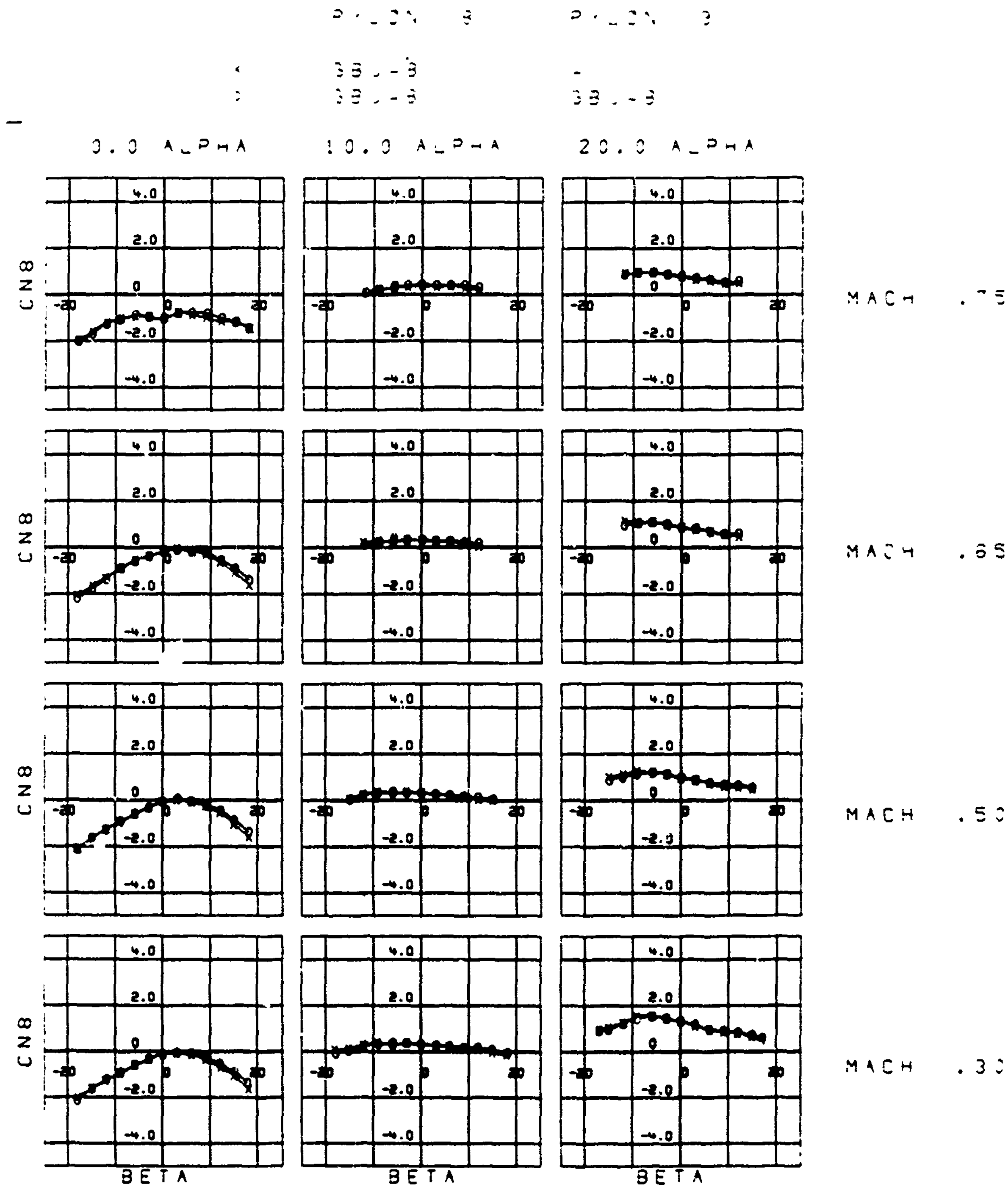


Figure 97. CN, Pylon 8 Versus Pylon 9, Cases 48, 62

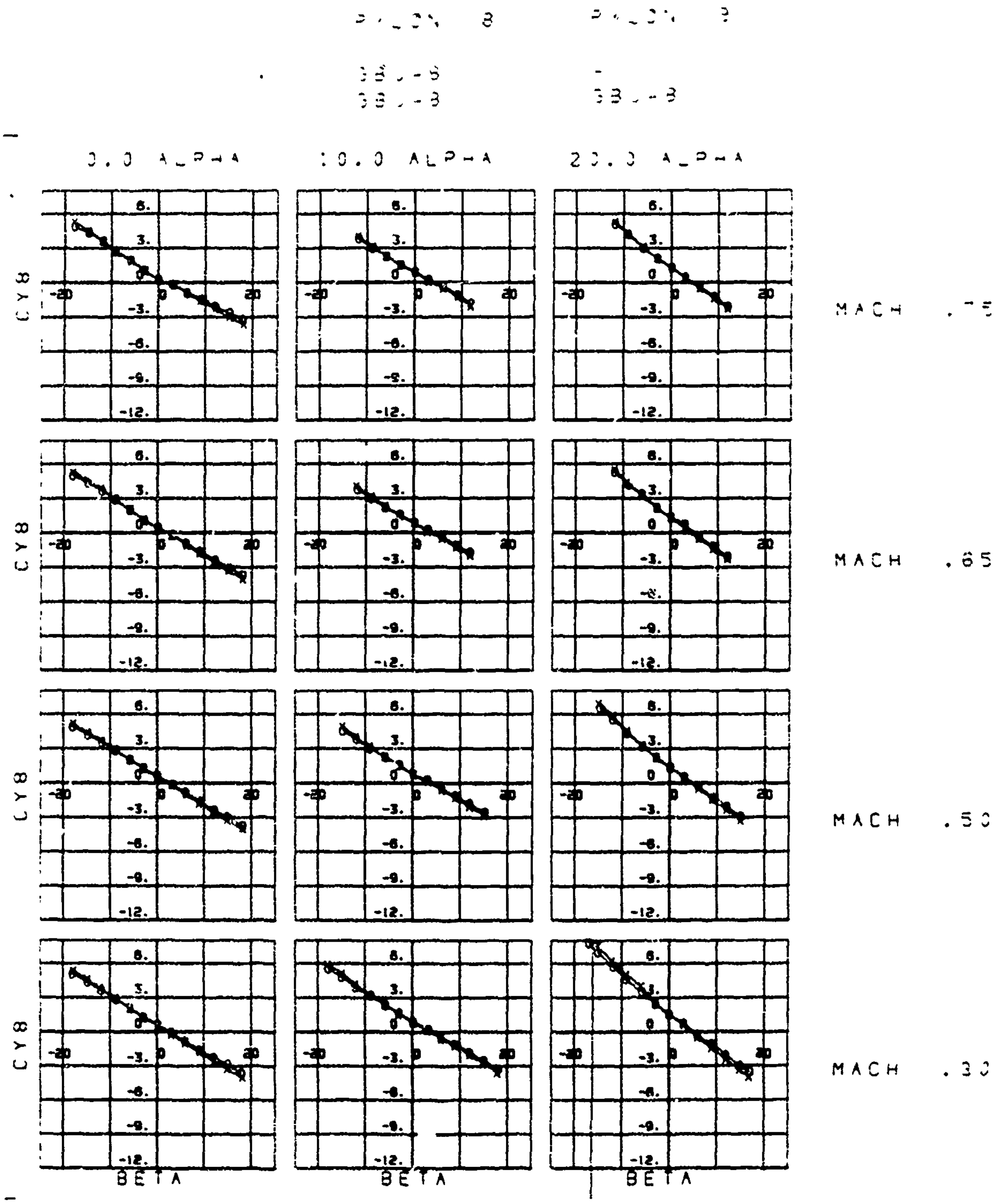


Figure 98. CY, Pylon 8 Versus Pylon 9, Cases 48, 62

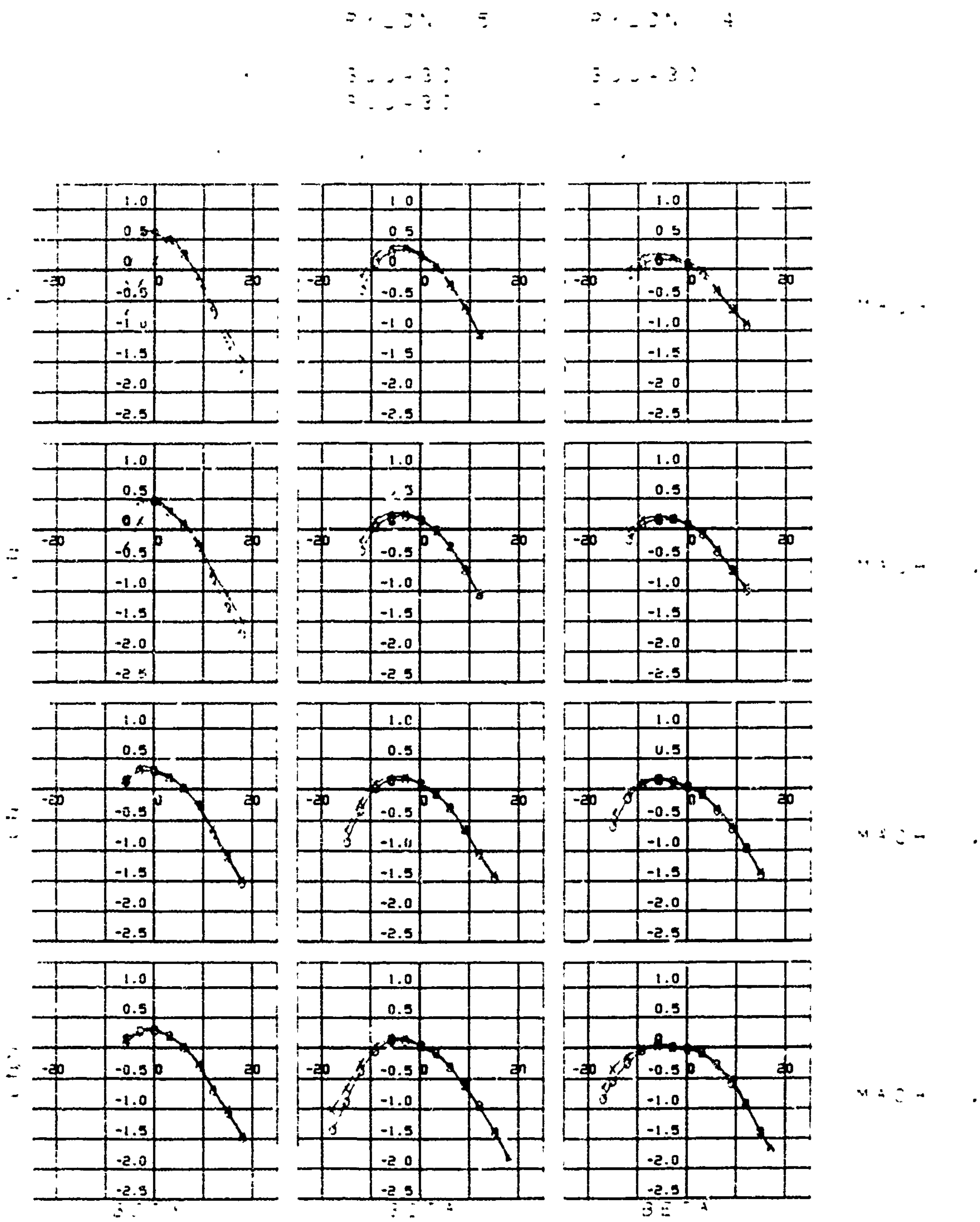


Figure 99. CN, Pylon 5 Versus Pylon 4, Cases 35, 39

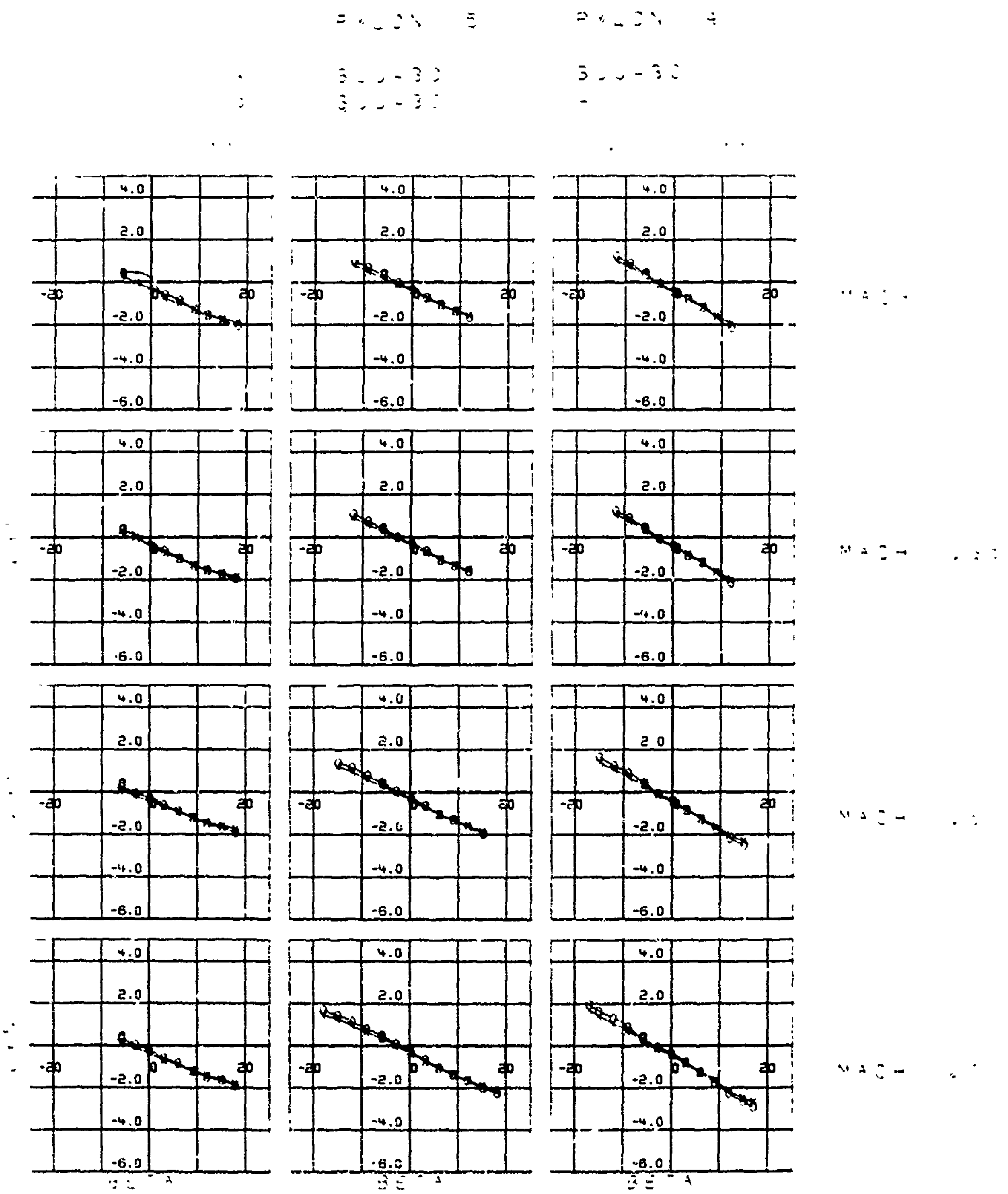


Figure 100. CY, Pylon 5 Versus Pylon 4, Cases 35, 39

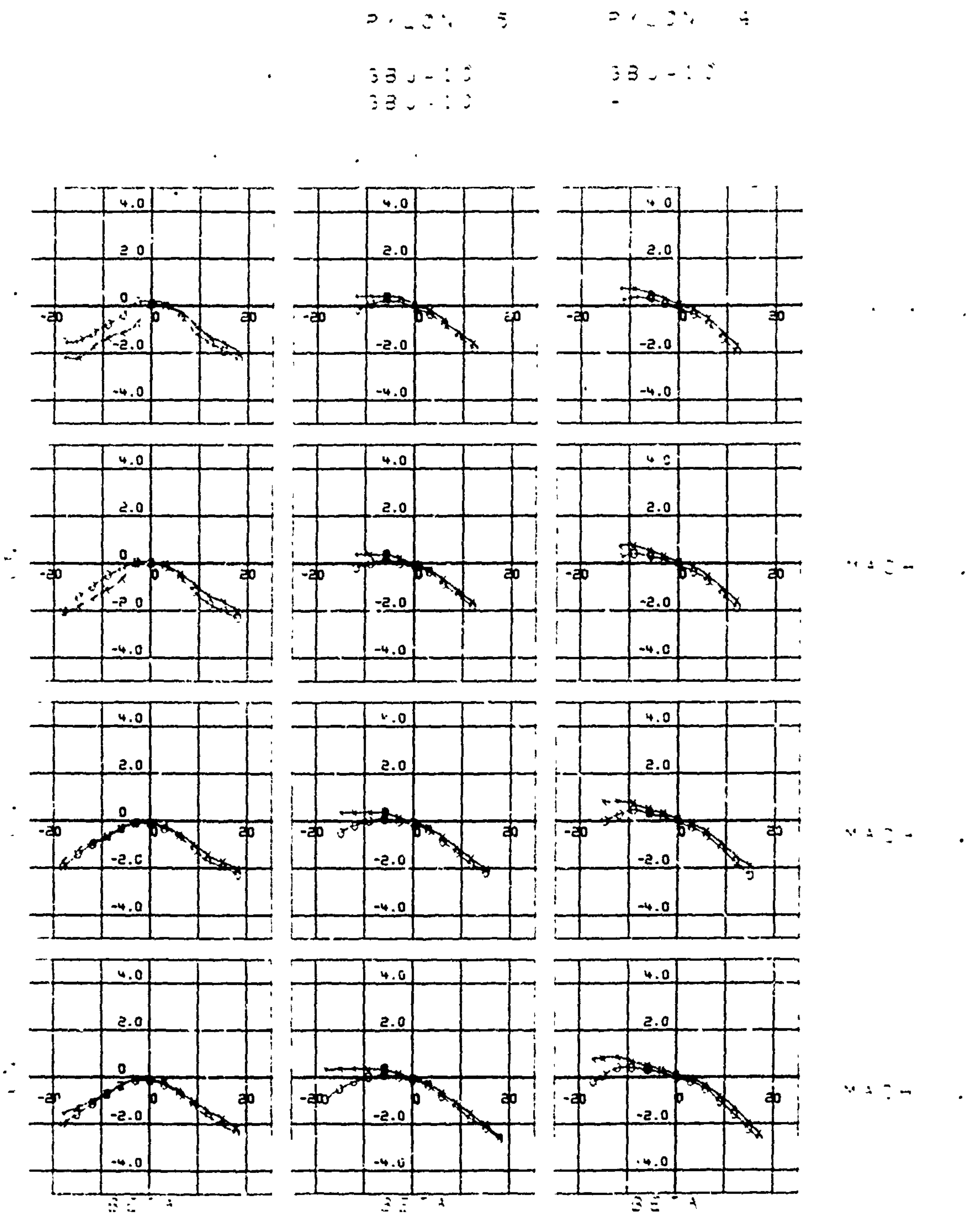


Figure 101. CN, Pylon 5 Versus Pylon 4, Cases 36, 42

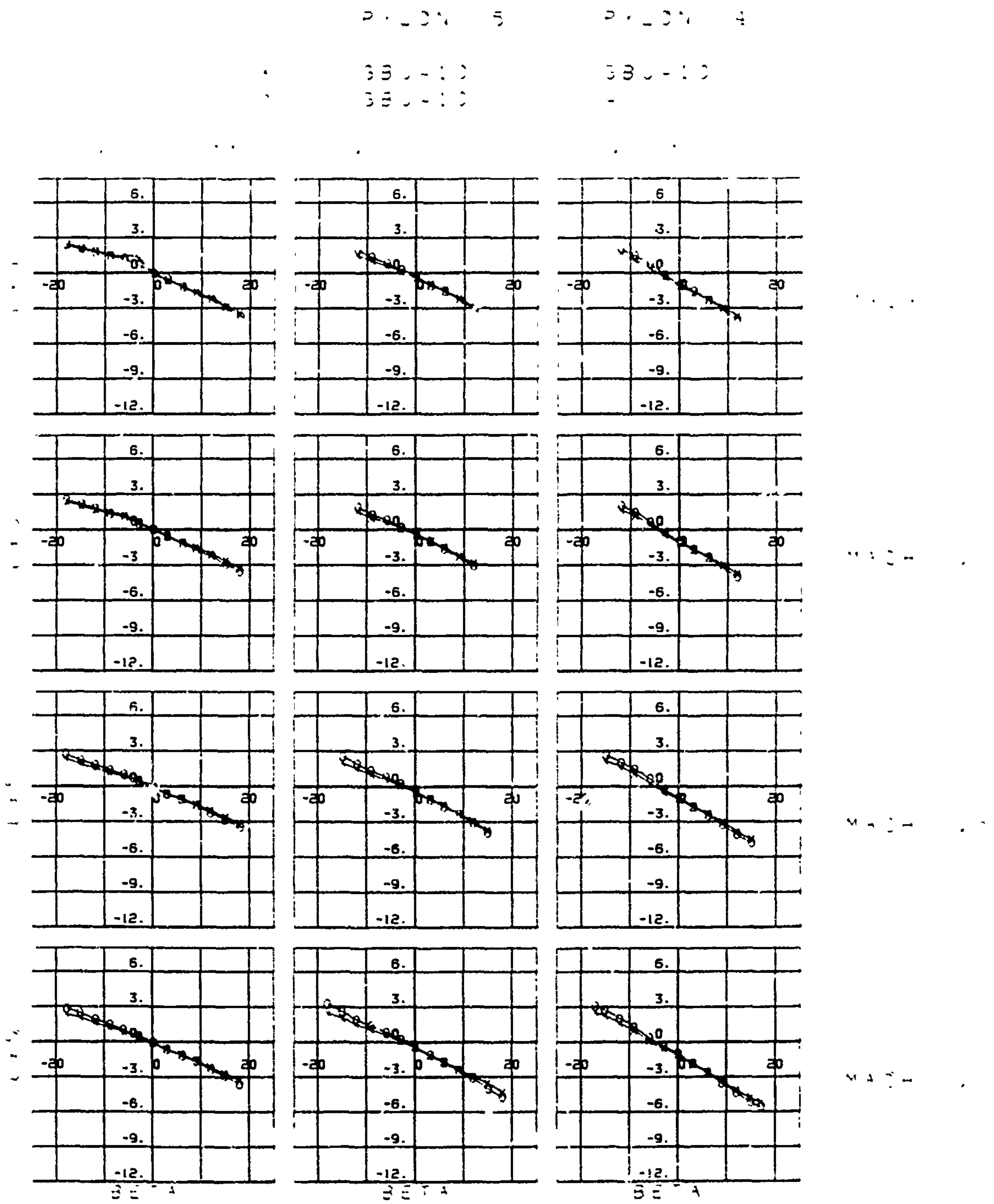


Figure 102. CY, Pylon 5 Versus Pylon 4, Cases 36, 42

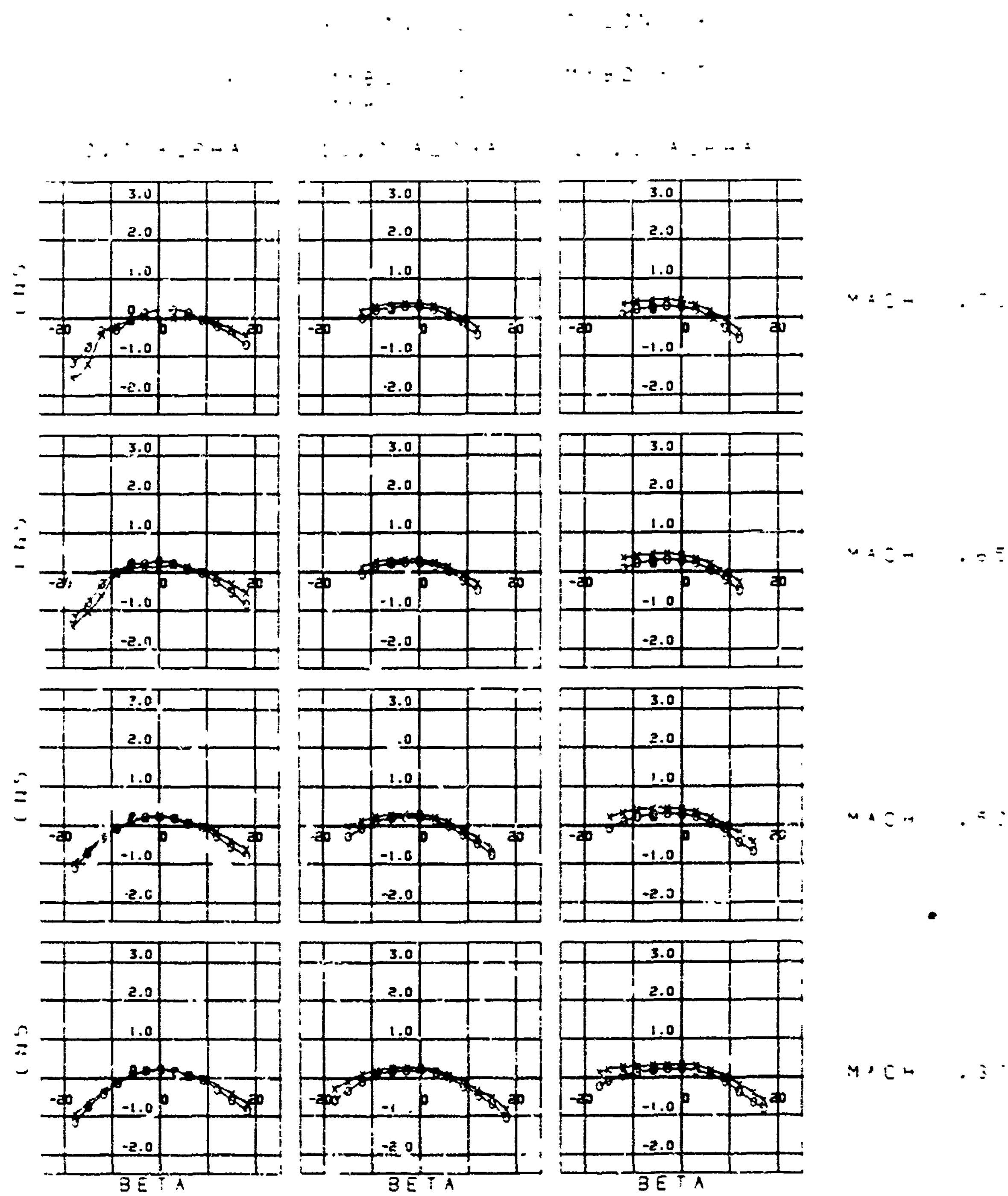


Figure 103. CN, Pylon 5 Versus Pylon 4, Cases 37, 40

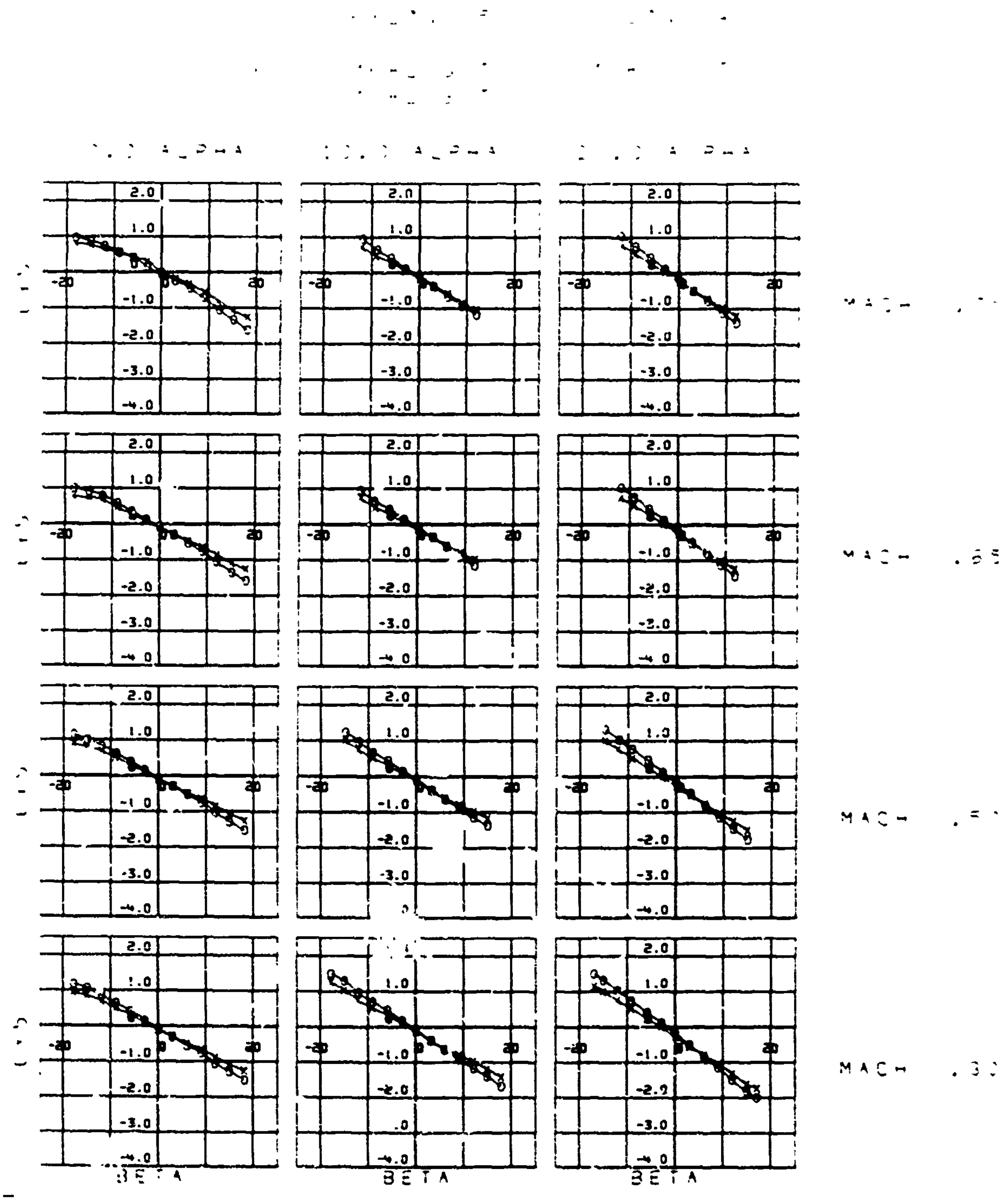


Figure 104. CY, Pylon 5 Versus Pylon 4, Cases 37, 40

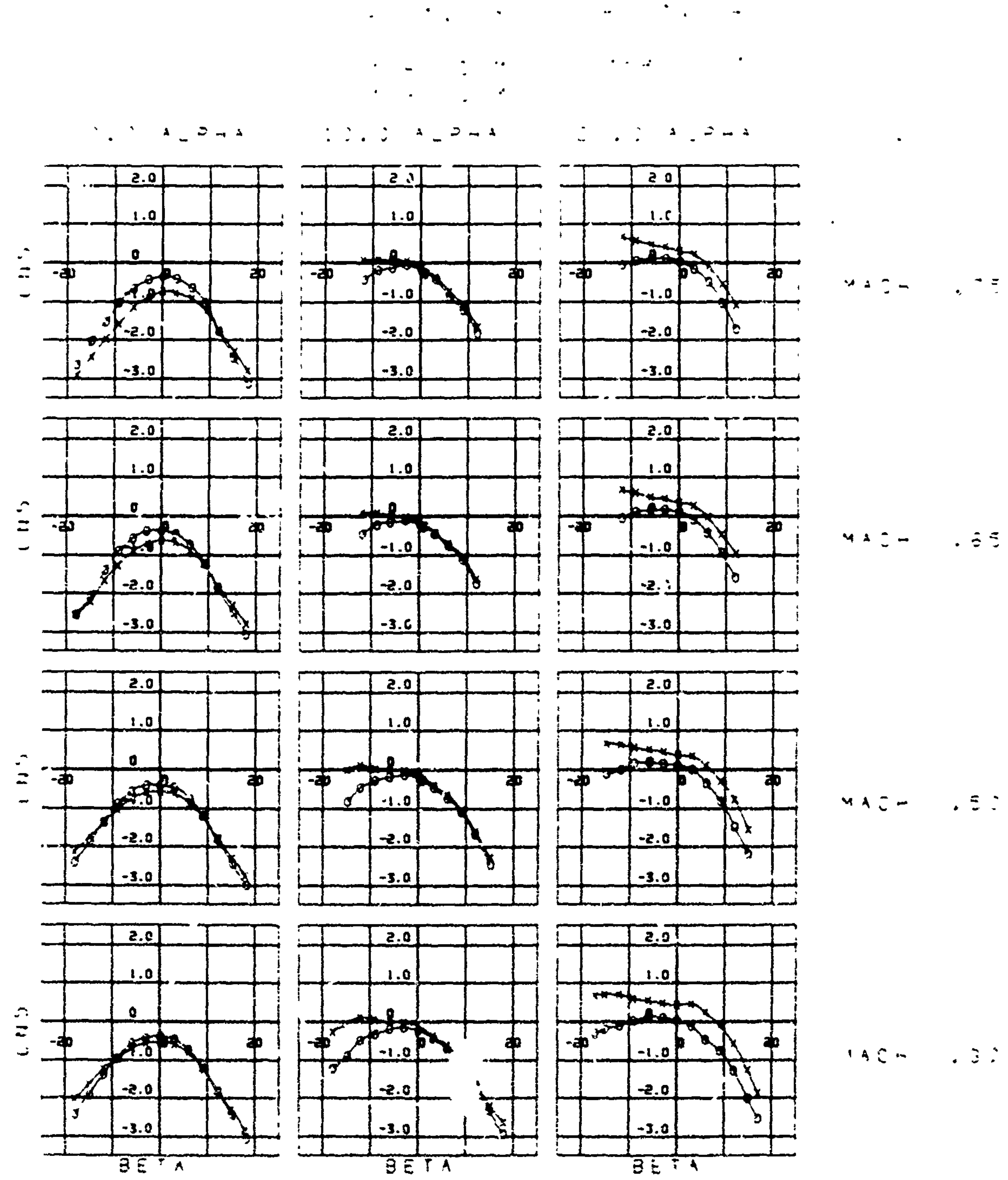


Figure 105. CN, Pylon 5 Versus Pylon 4, Cases 38, 41

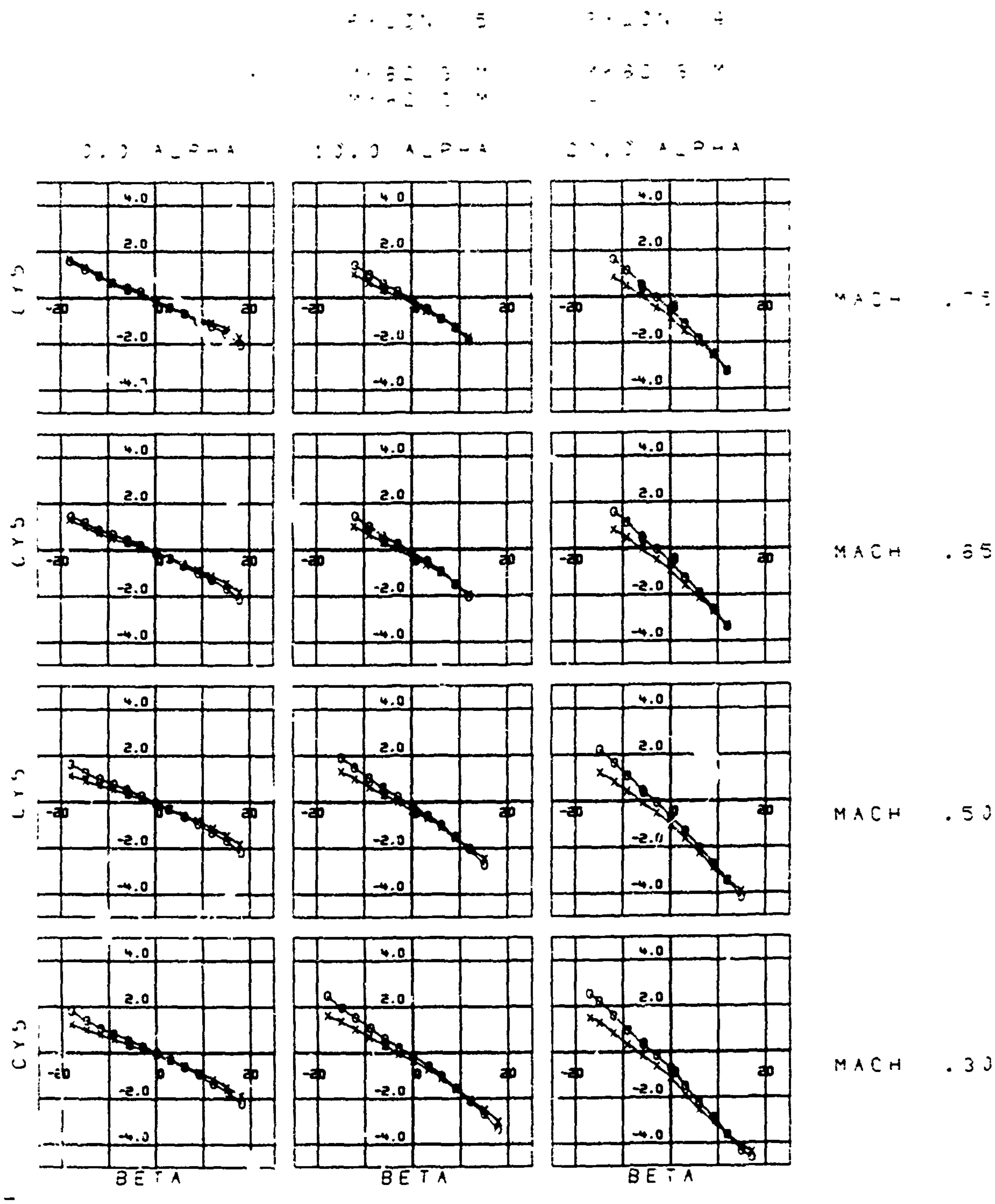


Figure 106. CY, Pylon 5 Versus Pylon 4, Cases 38, 41

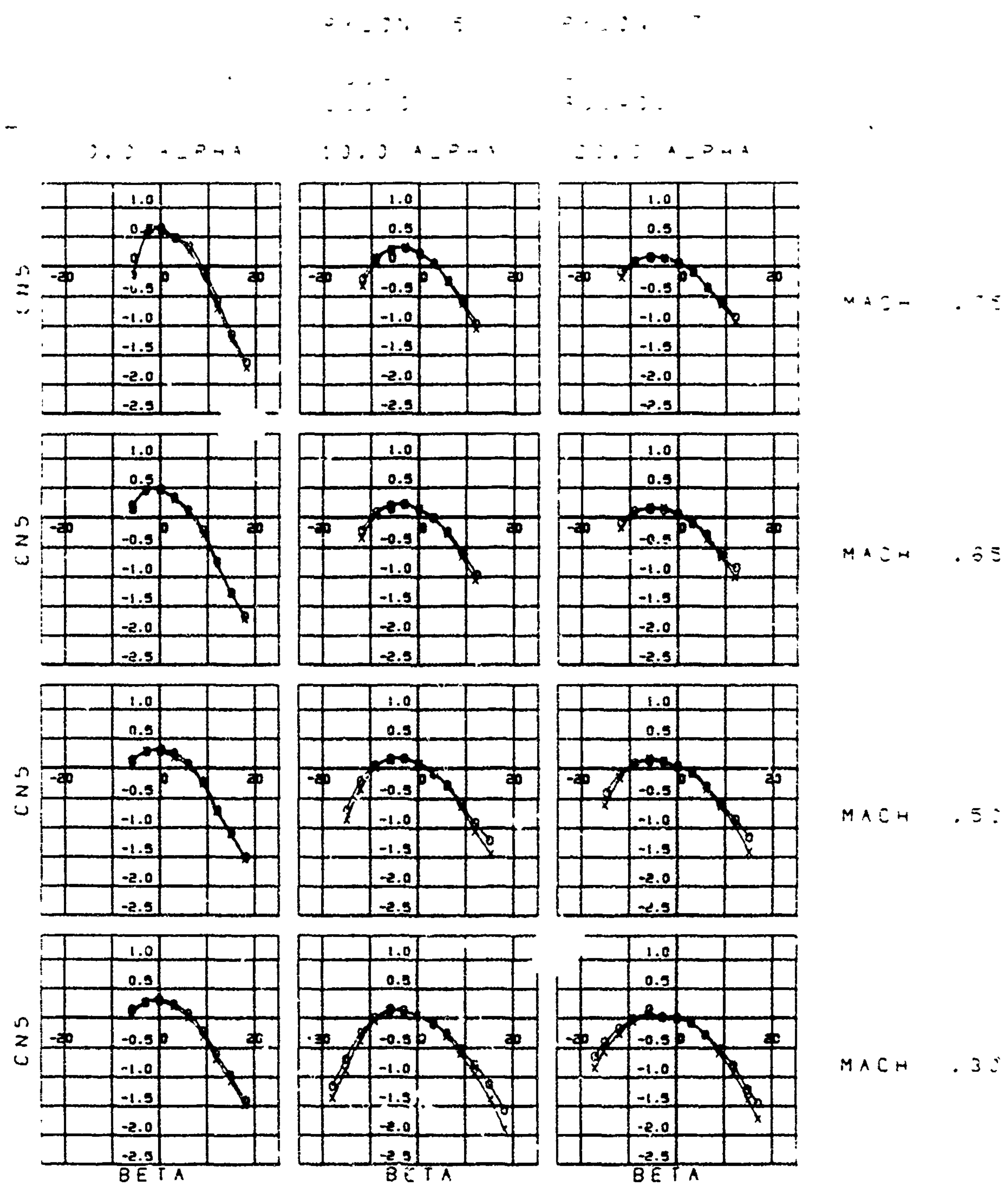


Figure 107. CN, Pylon 5 Versus Pylon 7, Cases 35, 43

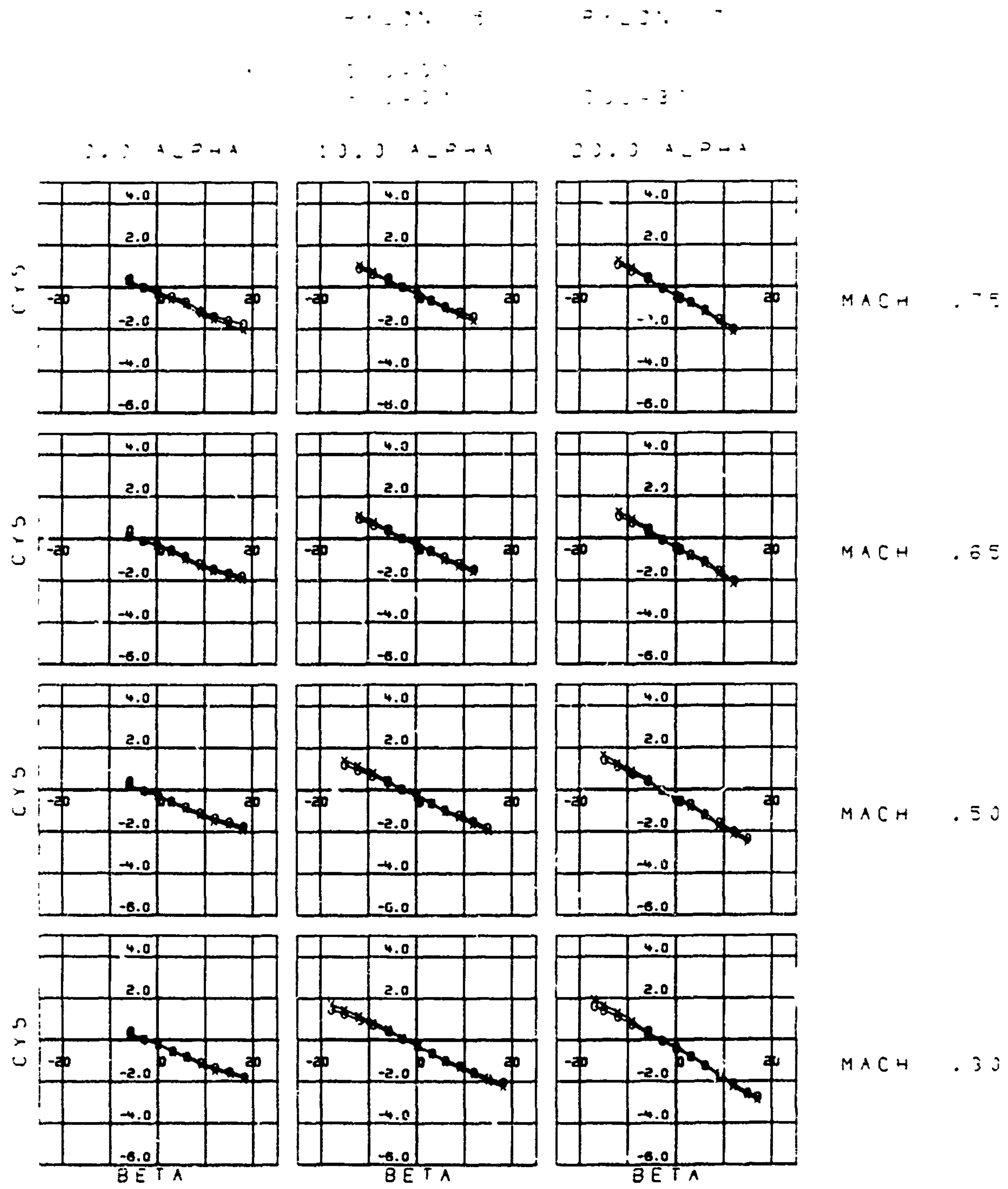


Figure 108. CY, Pylon 5 Versus Pylon 7, Cases 35, 43

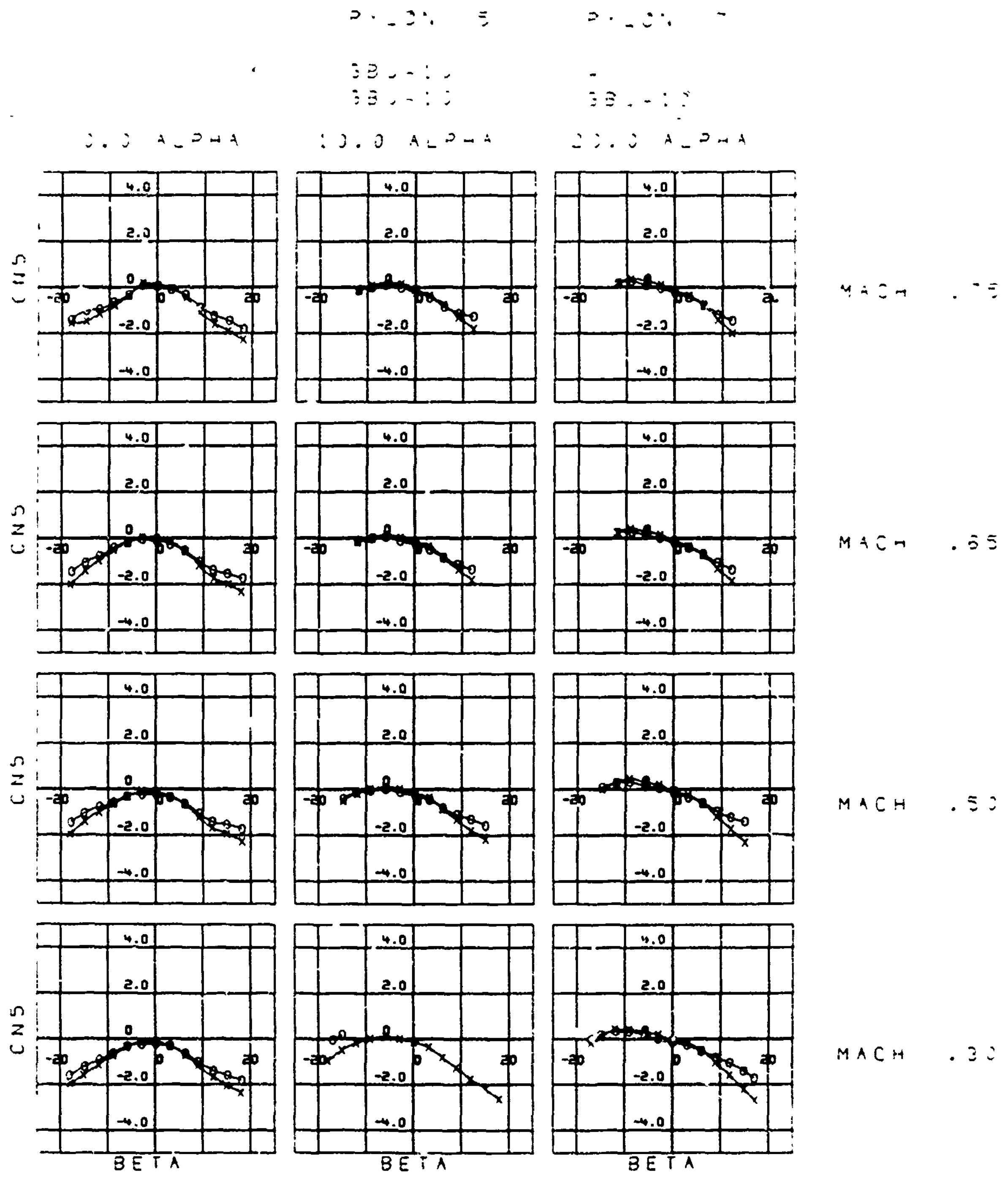


Figure 109. CN, Pylon 5 Versus Pylon 7, Cases 36, 46

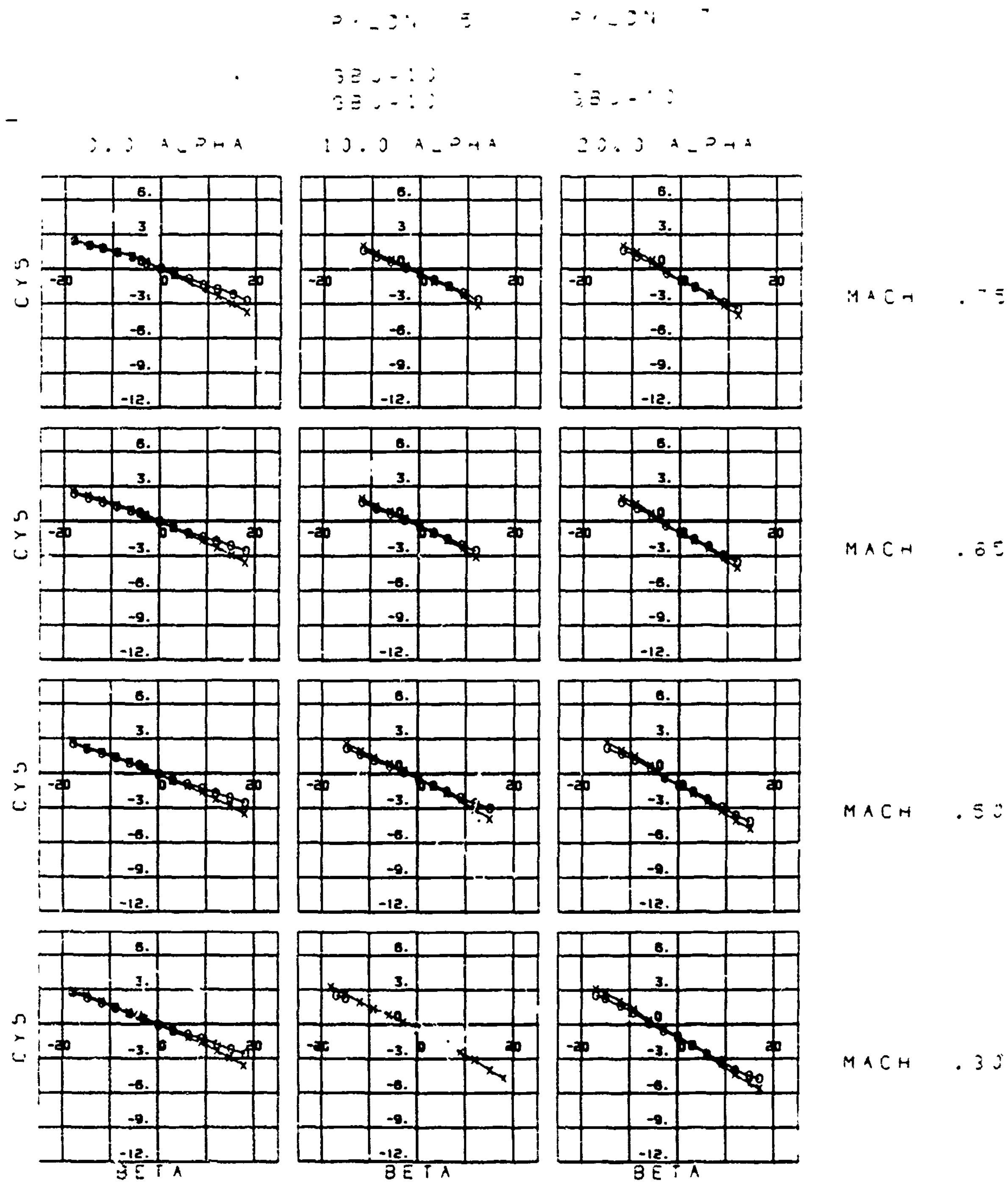


Figure 110. CY, Pylon 5 Versus Pylon 7, Cases 36, 46

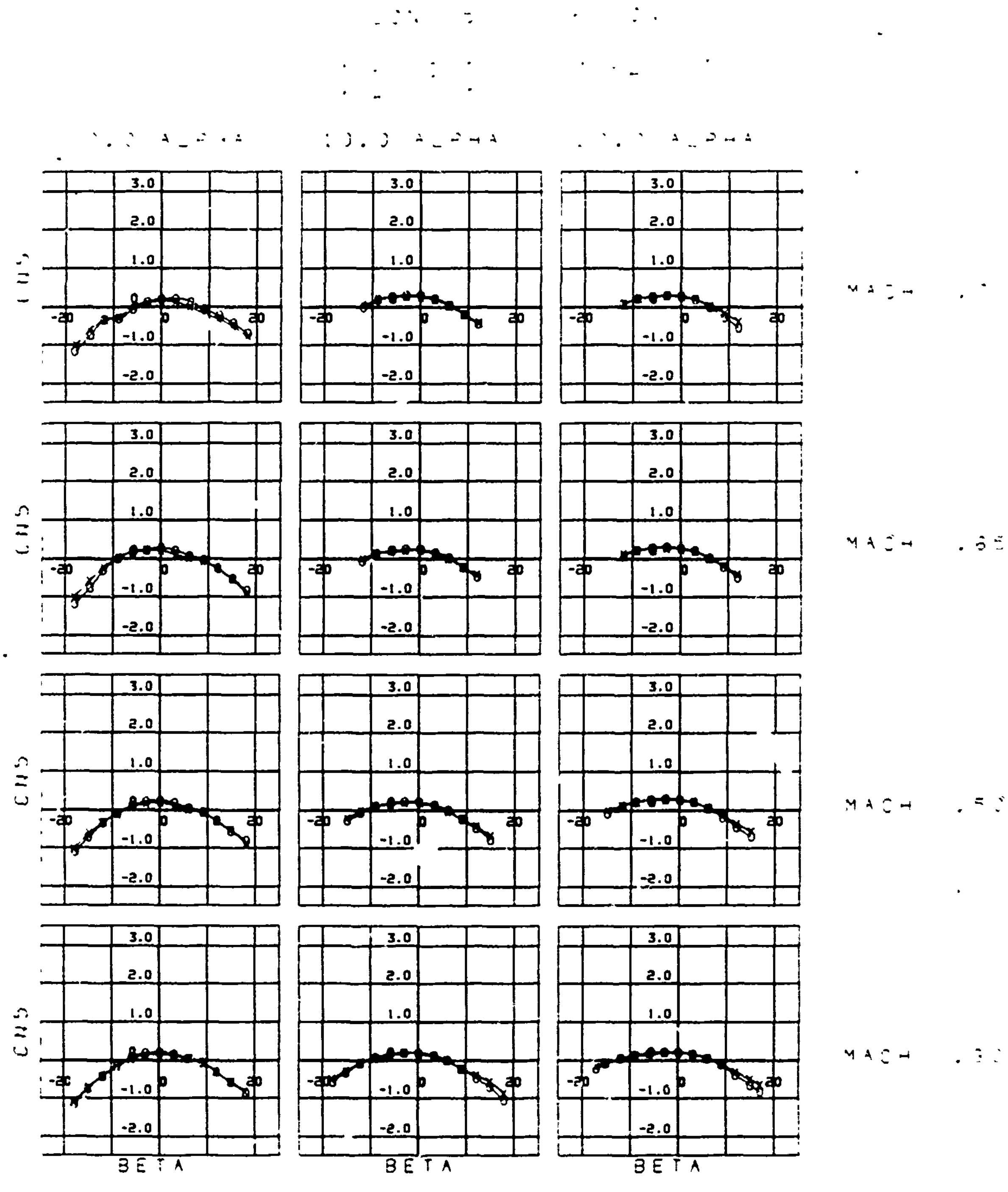


Figure 111. CN, Pylon 5 Versus Pylon 7, Cases 37, 44

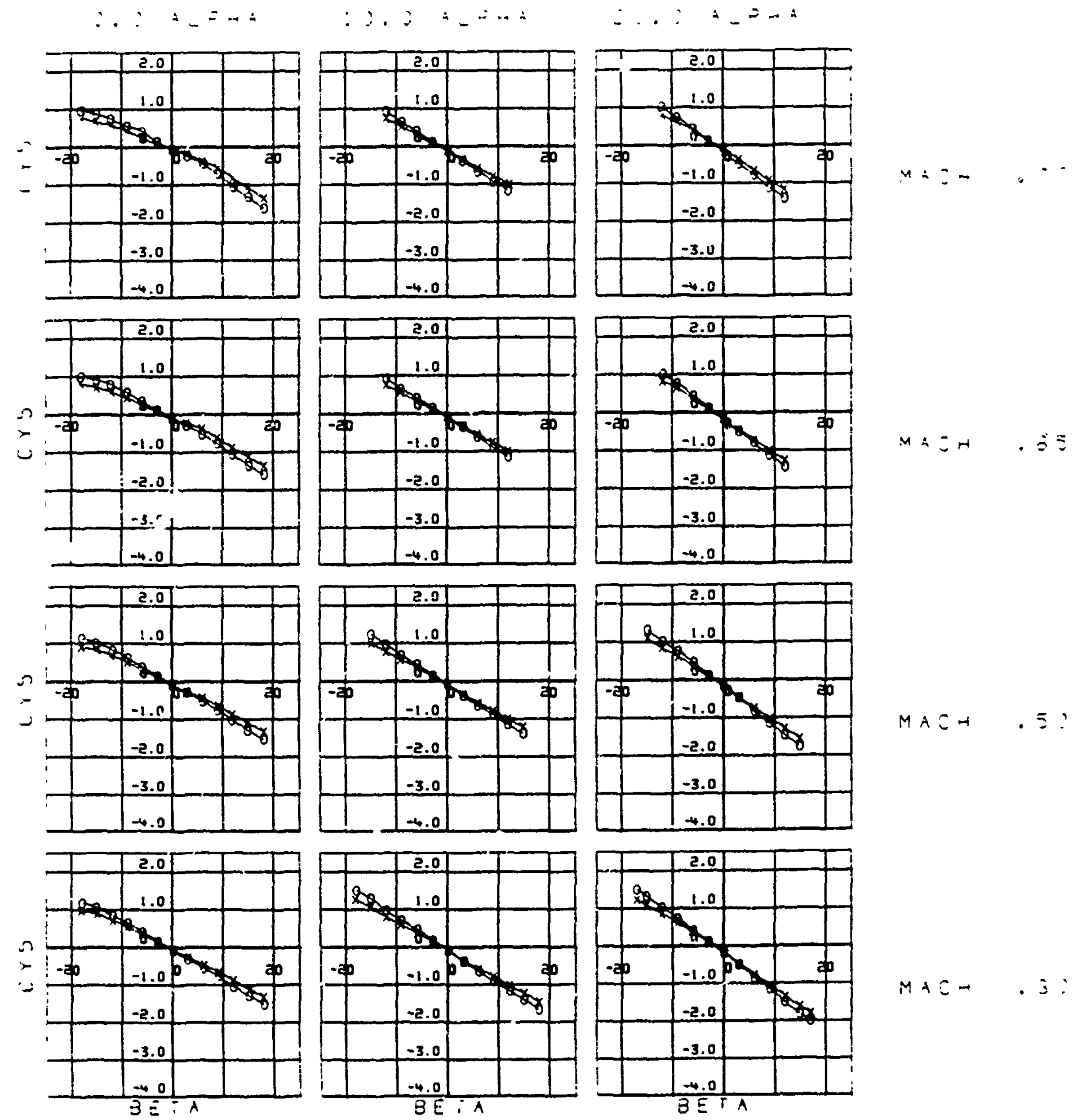


Figure 112. CY, Pylon 5 Versus Pylon 7, Cases 37, 44

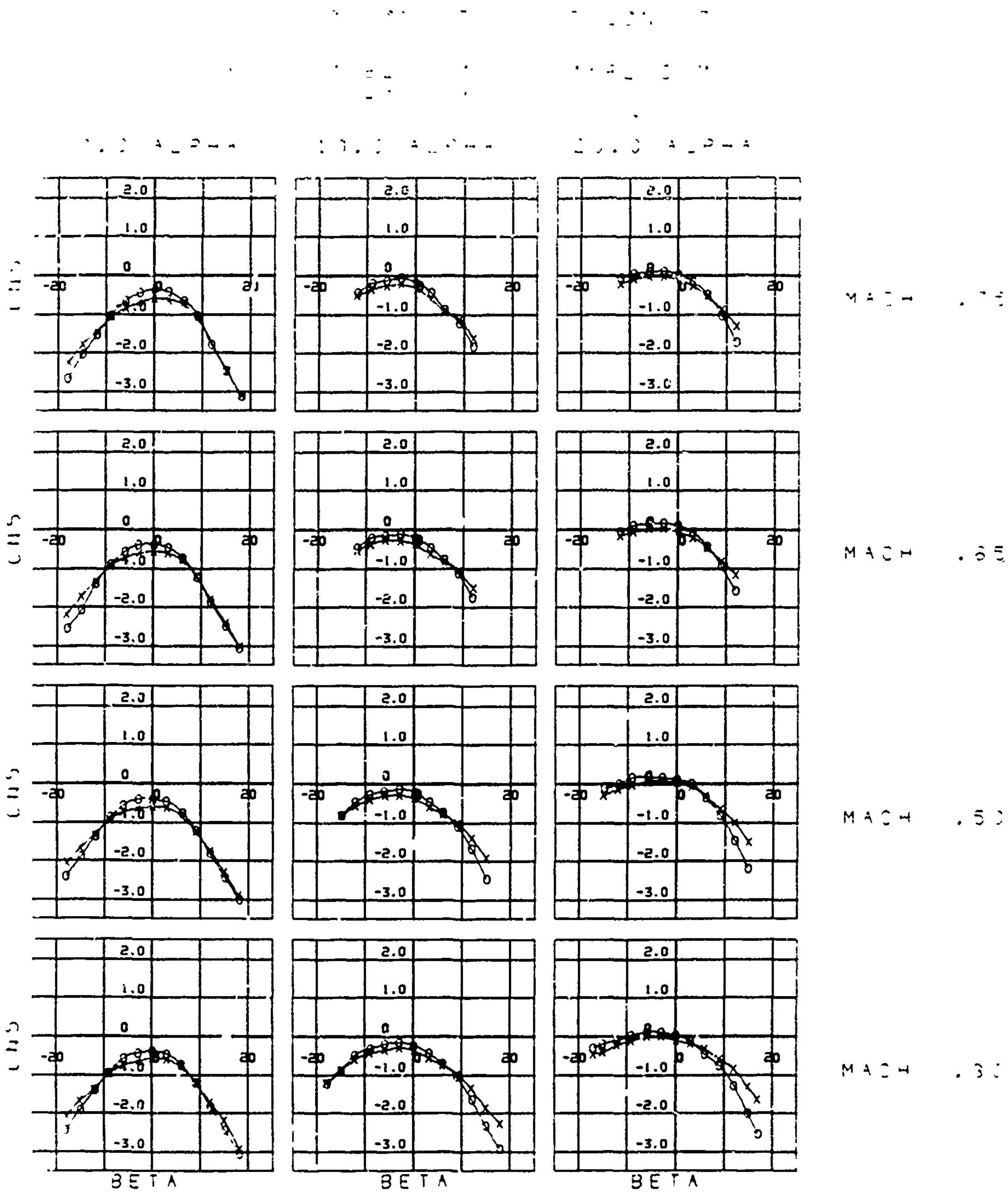


Figure 113. CN, Pylon 5 Versus Pylon 7, Cases 38, 45

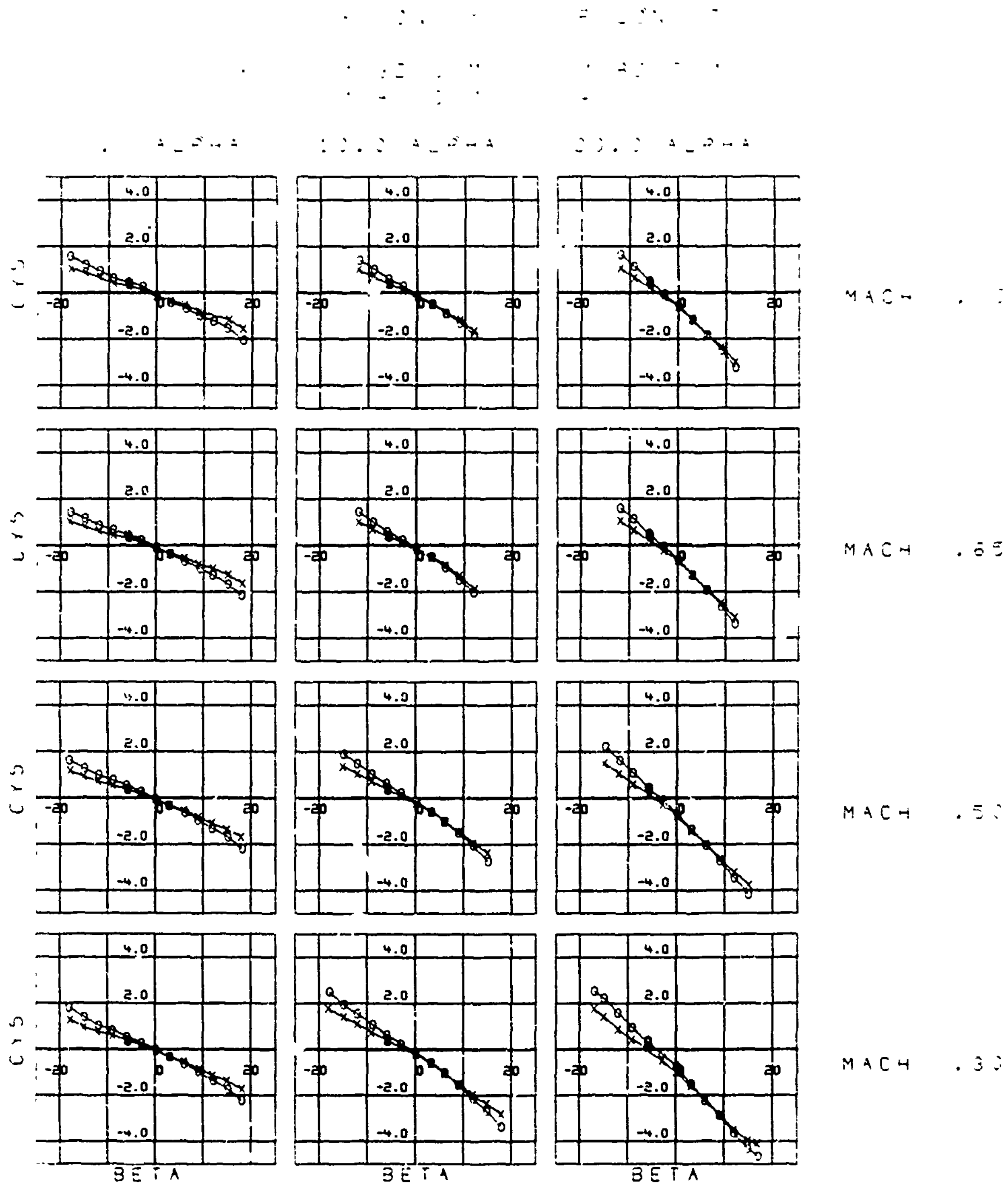


Figure 114. CY, Pylon 5 Versus Pylon 7, Cases 38, 45

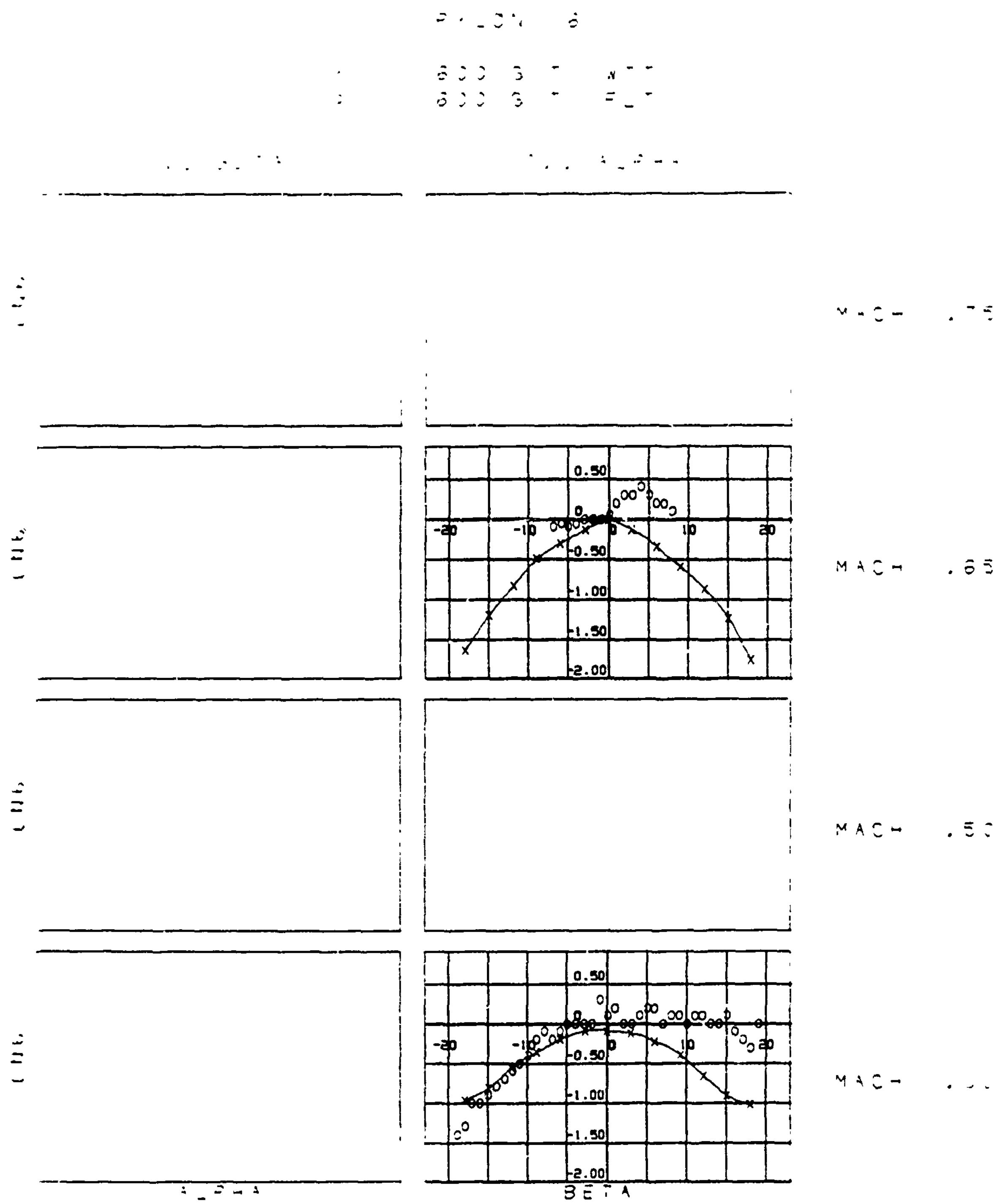


Figure 115. Wind Tunnel Versus 80% Loads Flight Test, Pylon 6, 600-Gallon Tank, CN

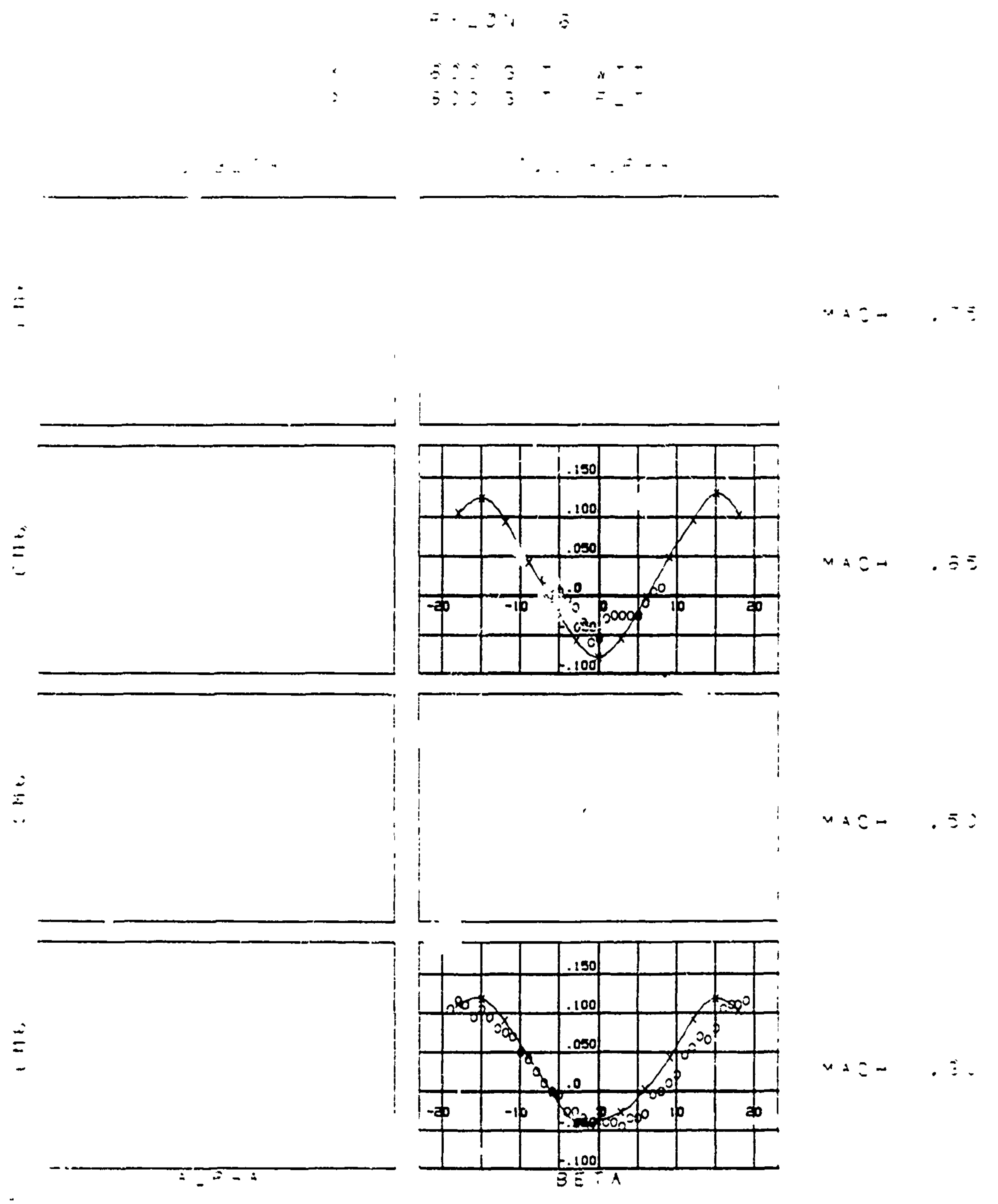


Figure 16. Wind Tunnel Versus 80% Loads Flight Test, Pylon 6, 600-Gallon Tank, CM

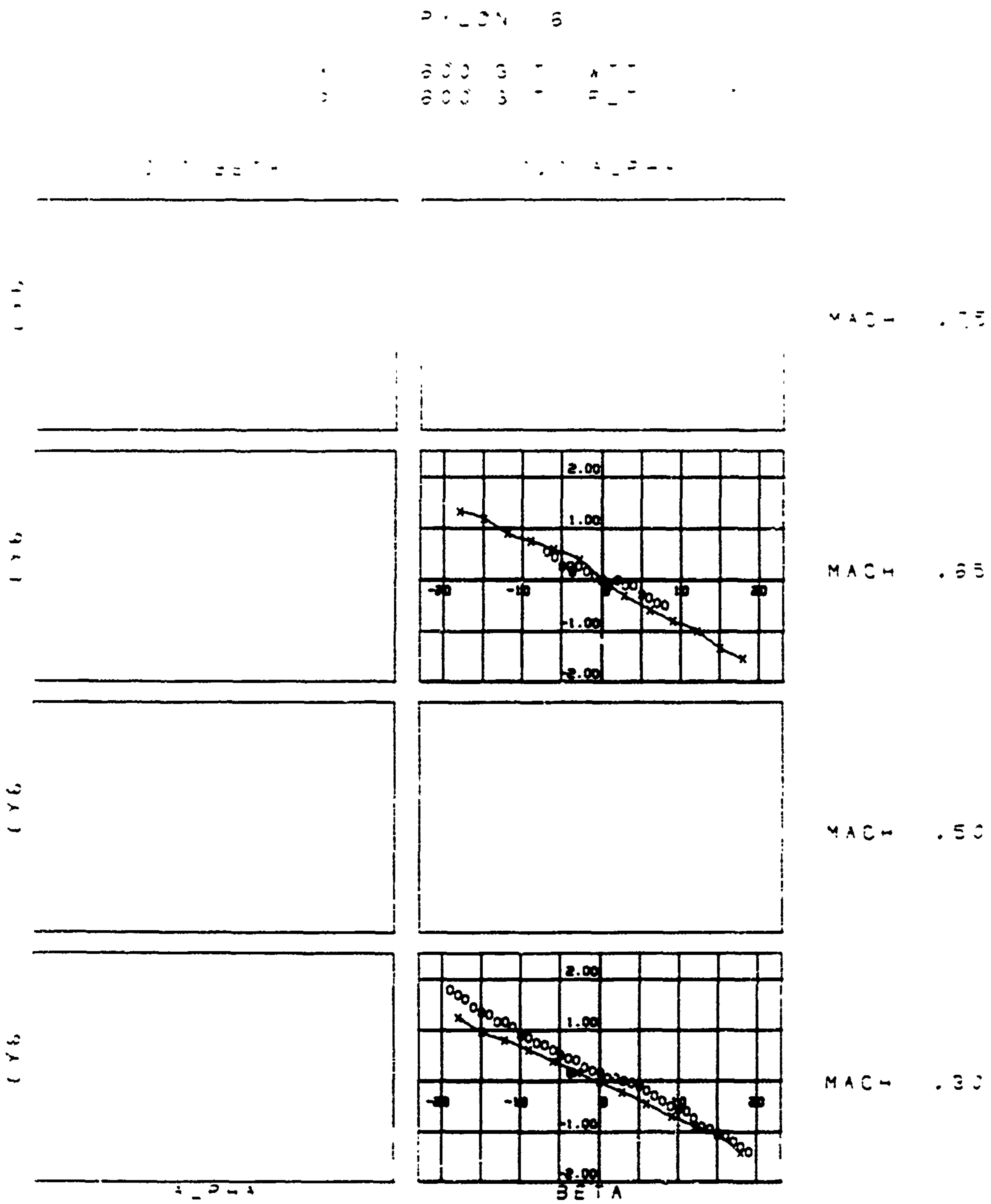


Figure 117. Wind Tunnel Versus 30% Loads Flight Test, Pylon 6, 600-Gallon Tank, CY

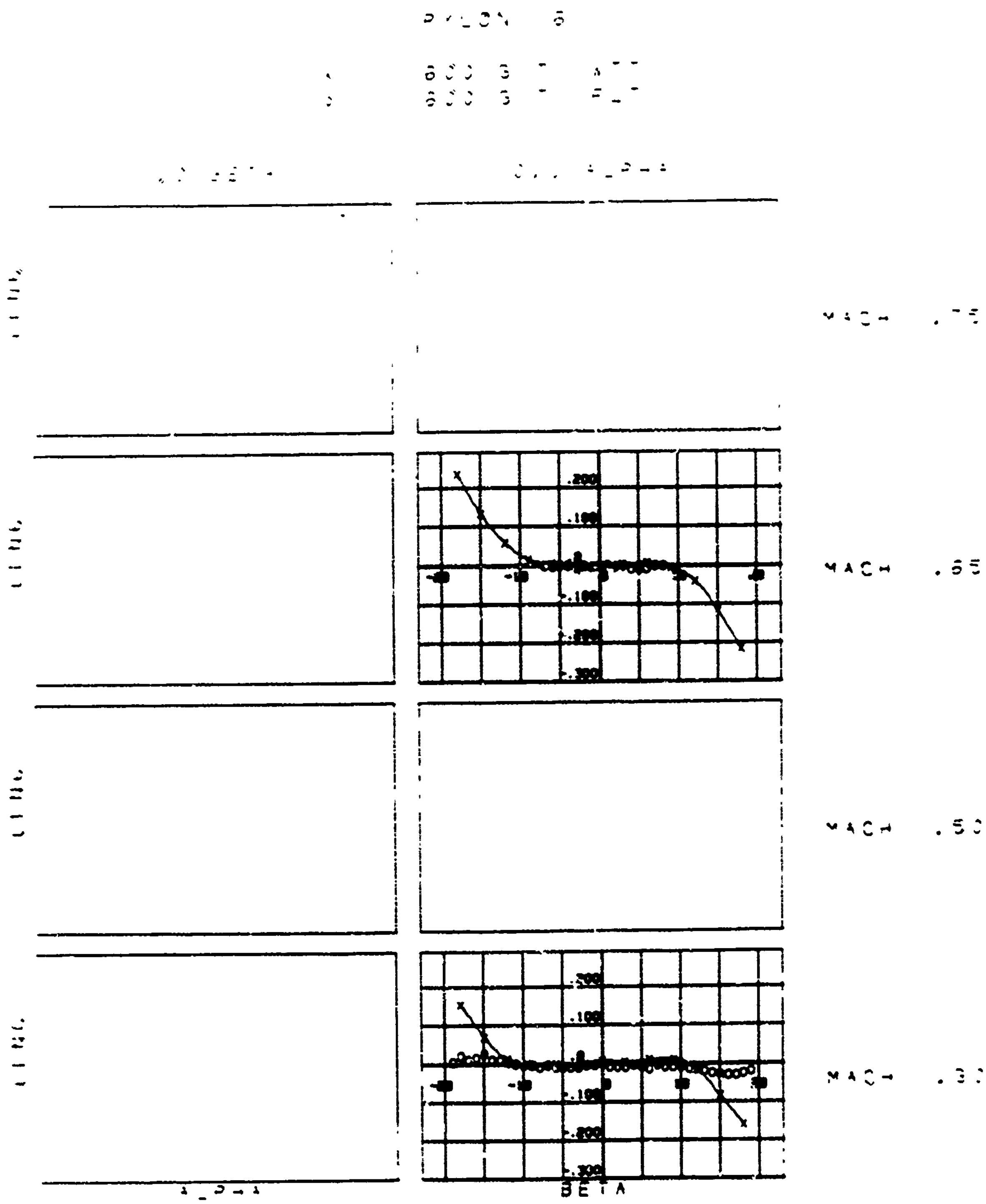


Figure 118. Wind Tunnel Versus 30% Loads Flight Test, Pylon 6, 600-Gallon Tank, CLN

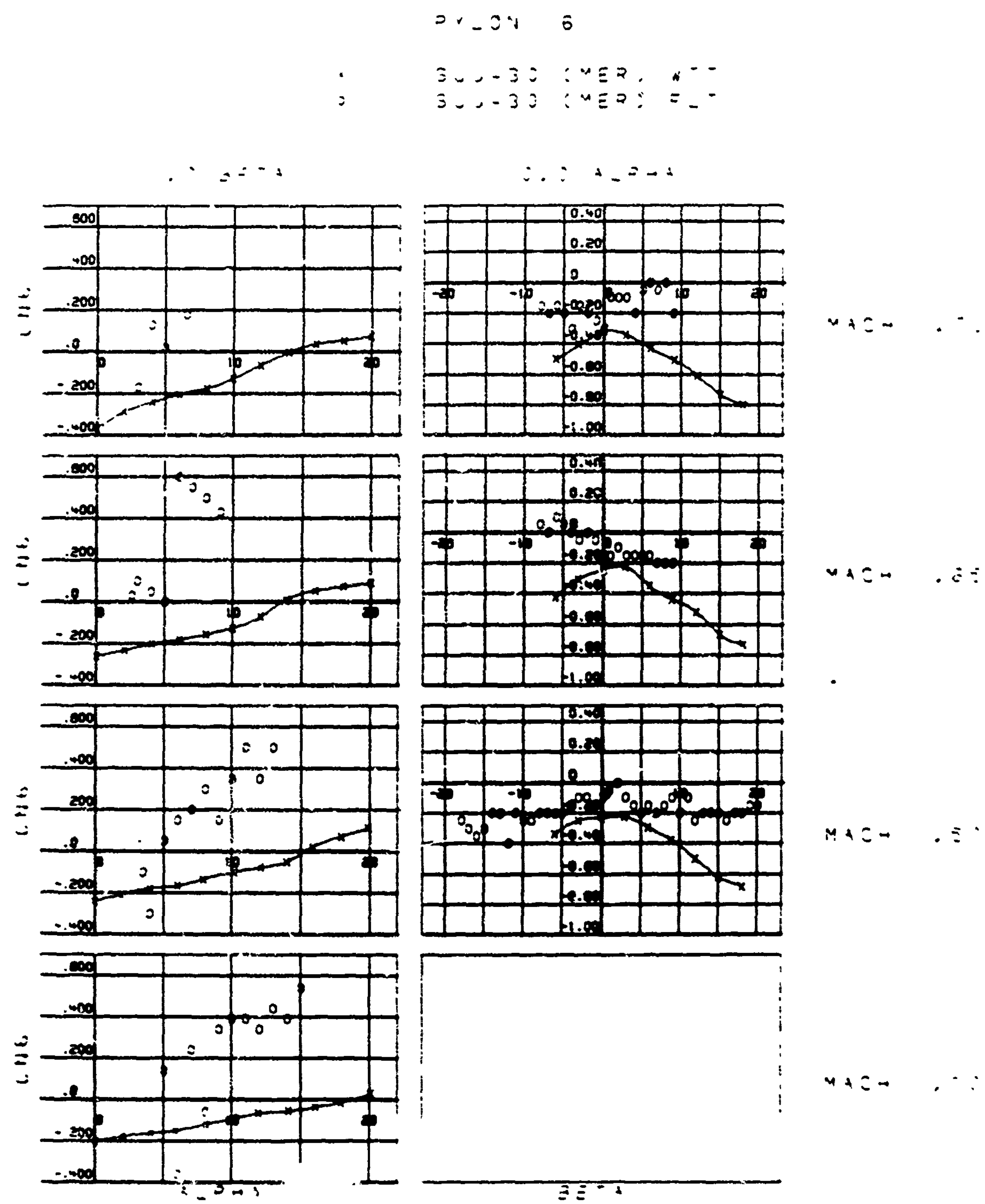


Figure 119. Wind Tunnel Versus 30% Loads Flight Test, Pylon 6,SUU-30 (MER), CN

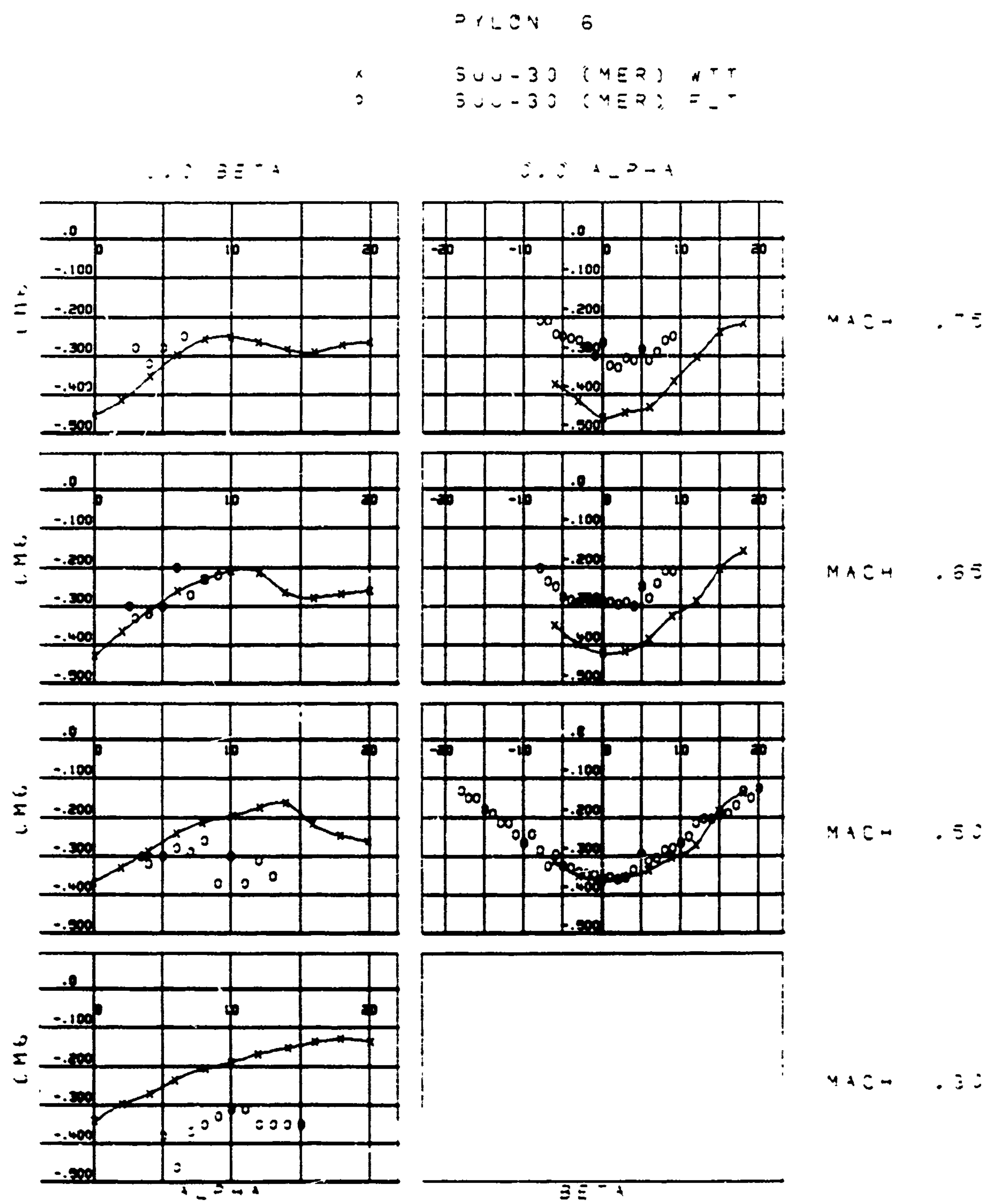


Figure 120. Wind Tunnel Versus 80% Loads Flight Test, Pylon 6, SUU-30 (MER), CM

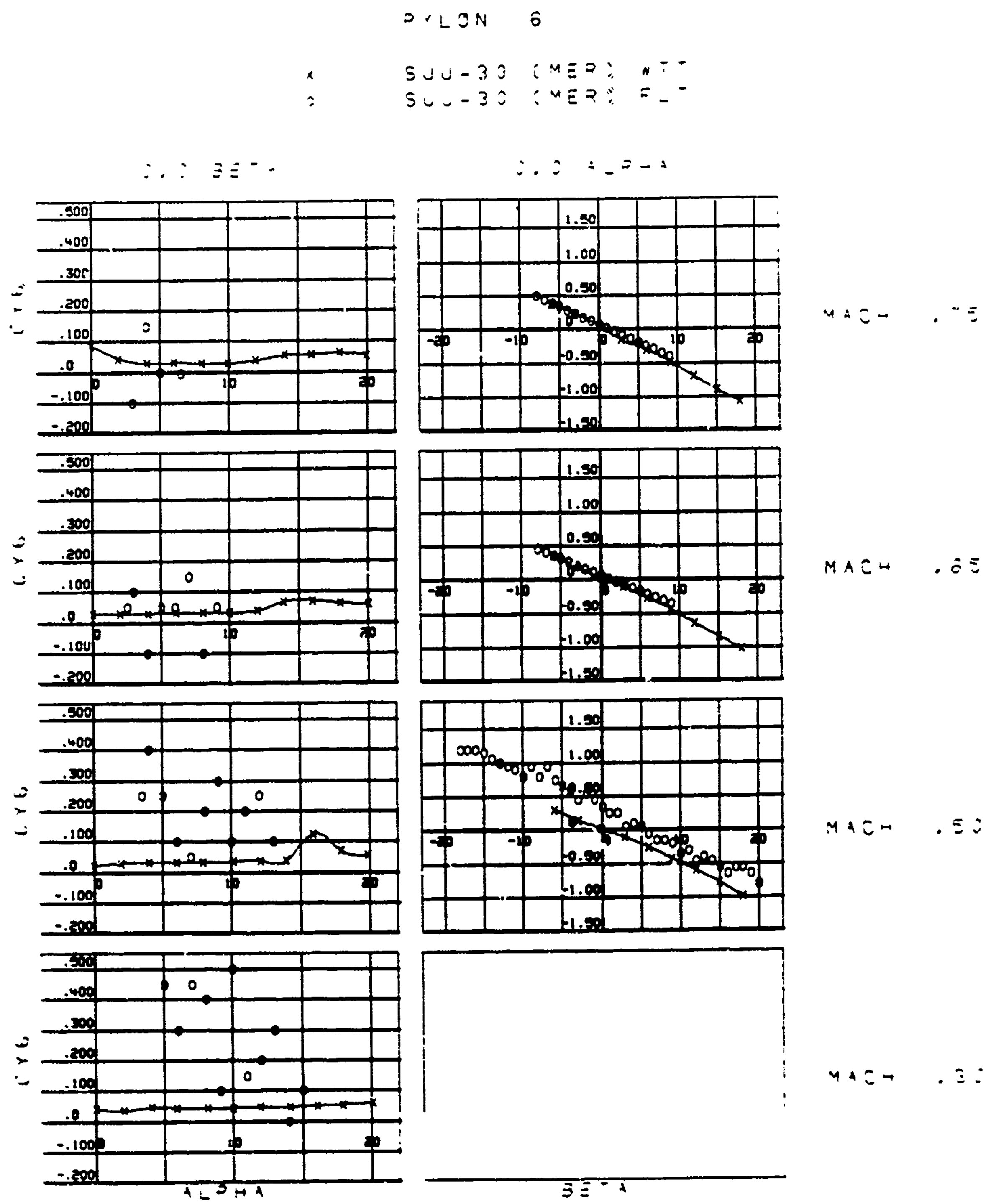


Figure 121. Wind Tunnel Versus 80% Loads Flight Test, Pylon 6, SUU-30 (MER), CY

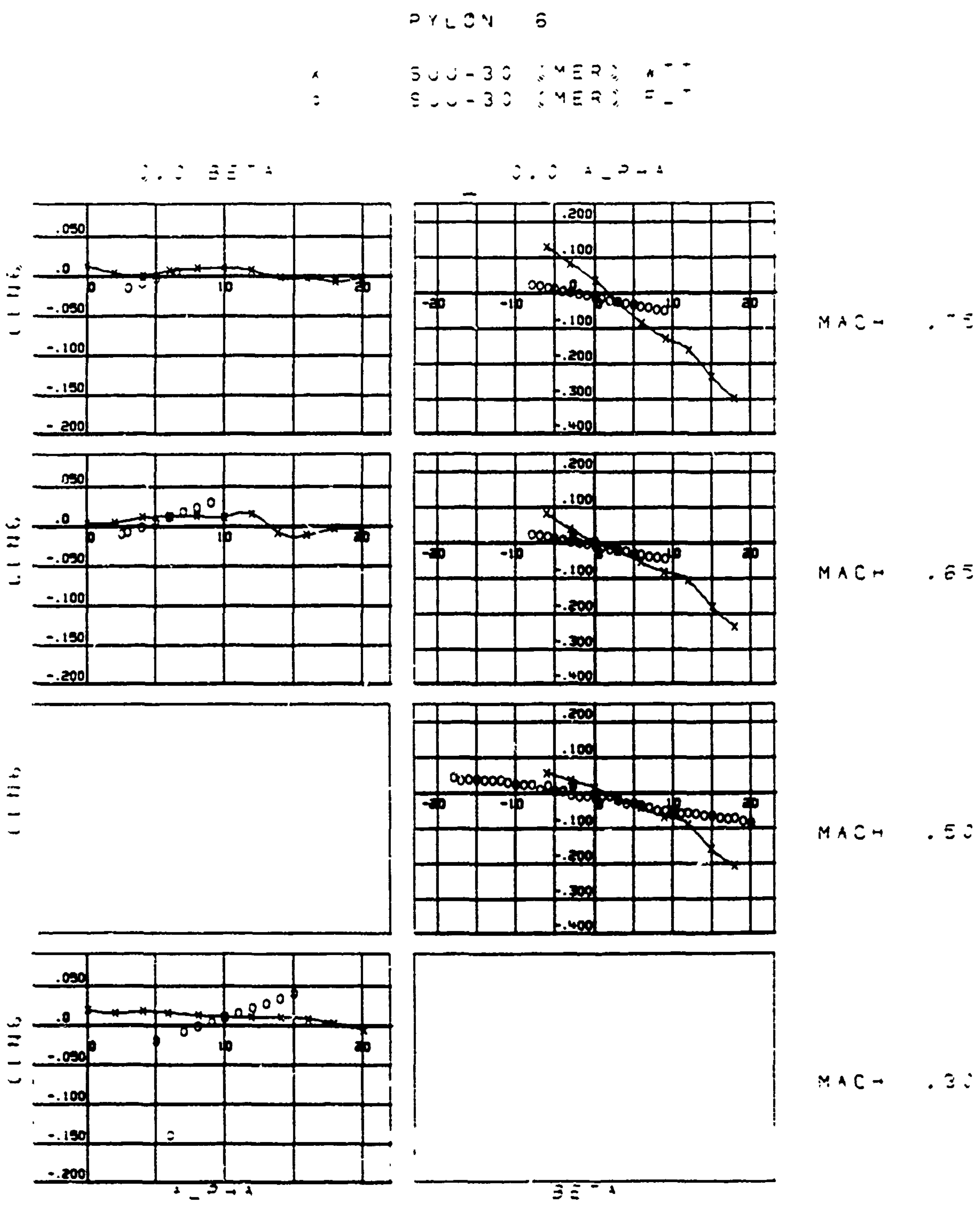


Figure 122. Wind Tunnel Versus 80% Loads Flight Test, Pylon 6, SUU-30 (MER), CLN

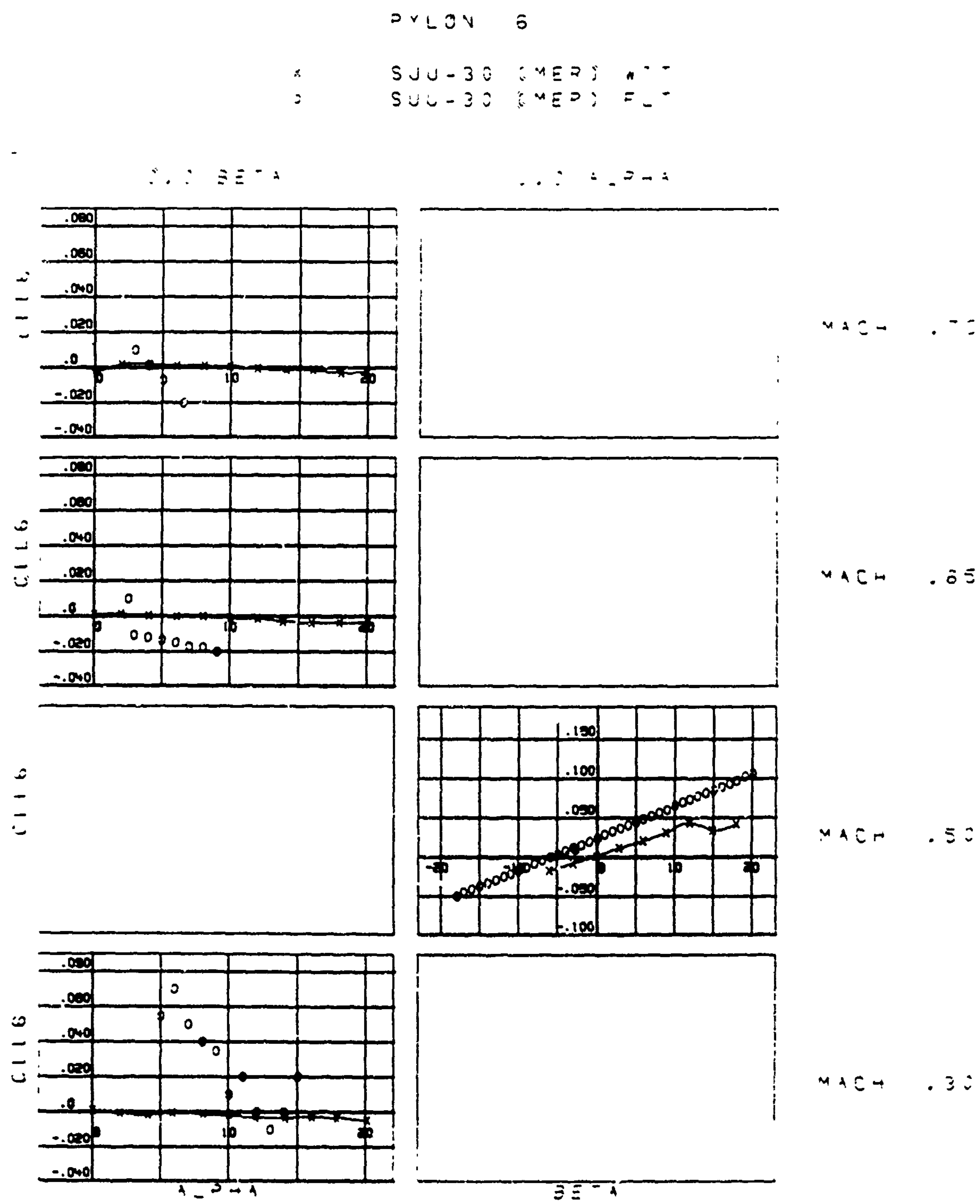


Figure 123. Wind Tunnel Versus 80% Loads Flight Test, Pylon 6, SUU-30 (MER), CLL

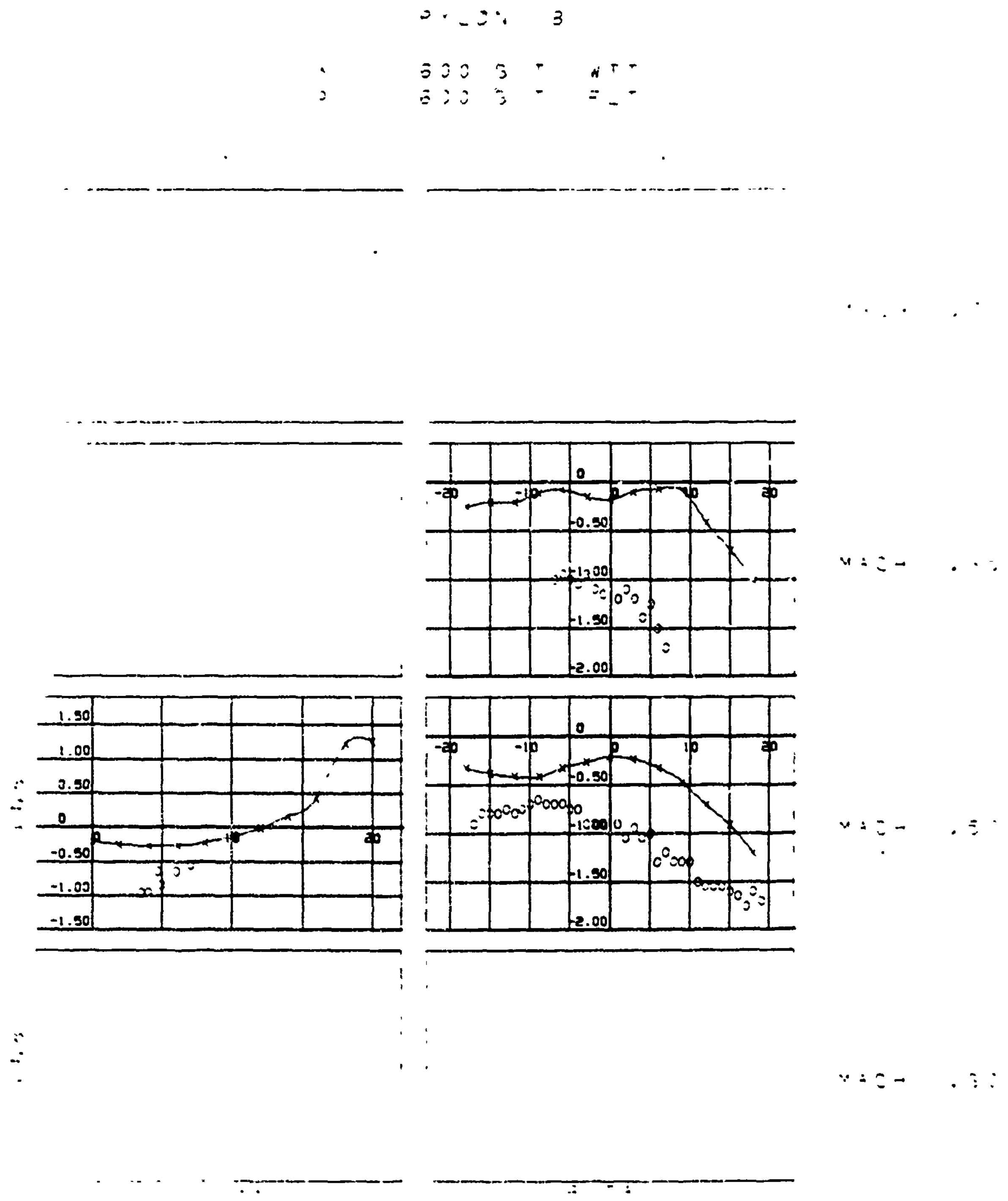


Figure 124. Wind Tunnel Versus 80% Loads Flight Test, Pylon 8, 600-Gallon Tank, CN

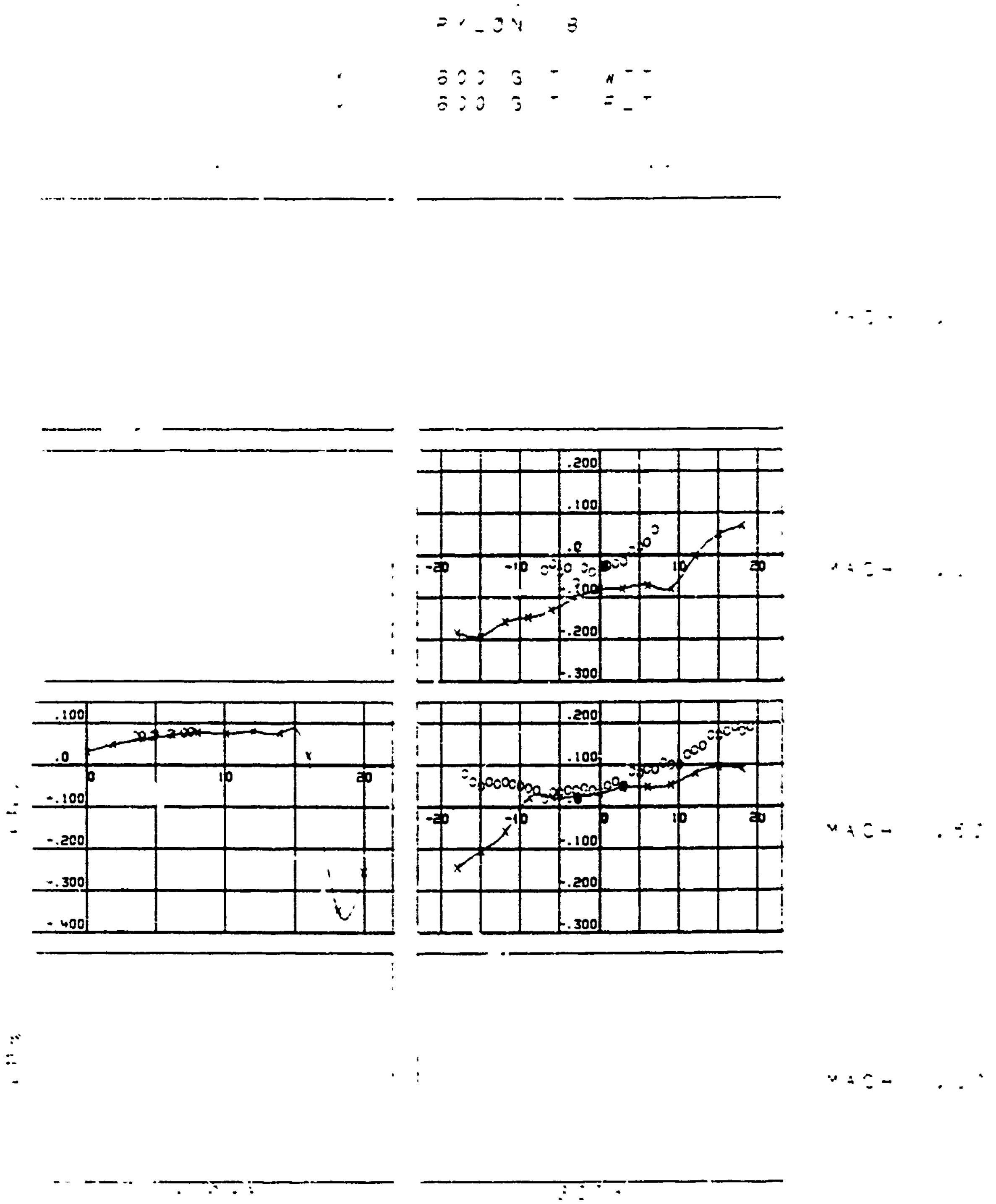


Figure 125. Wind Tunnel Versus 80% Loads Flight Test,
Pylon 8, 600-Gallon Tank, CM

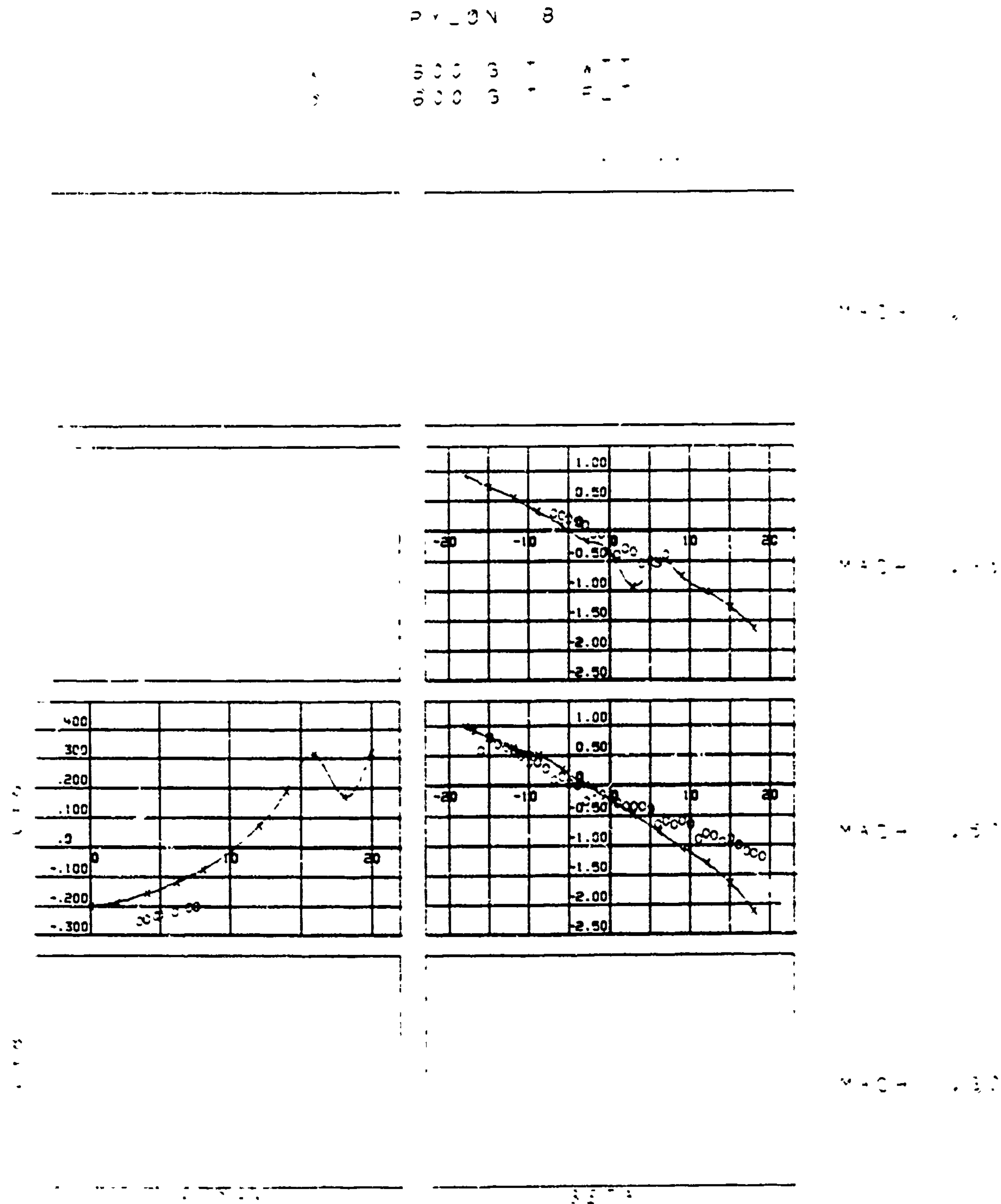


Figure 126. Wind Tunnel Versus 80% Loads Flight Test, Pylon 8, 600-Gallon Tank, CY

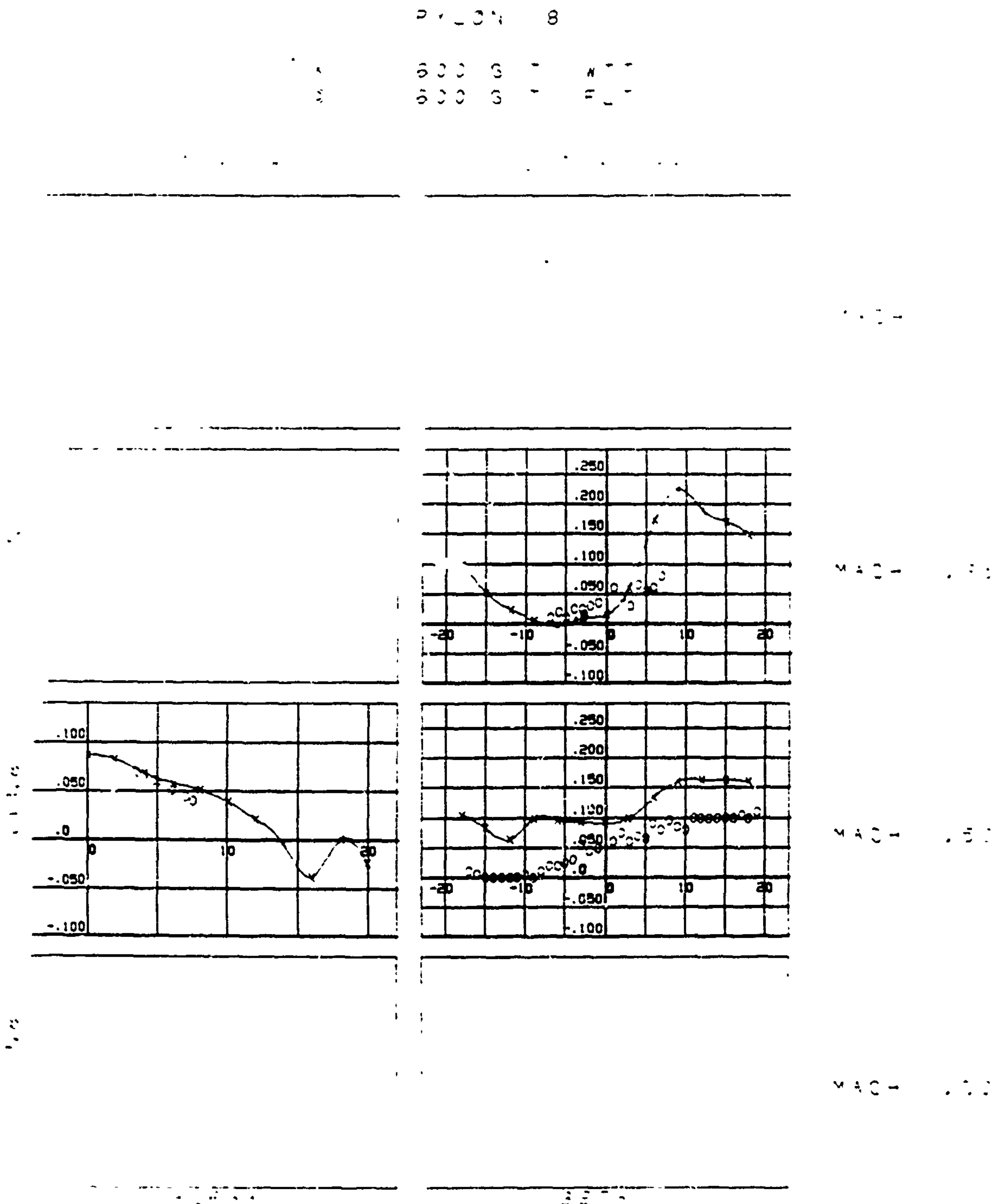


Figure 127. Wind Tunnel Versus 80% Loads Flight Test, Pylon 8, 600-Gallon Tank, CLN

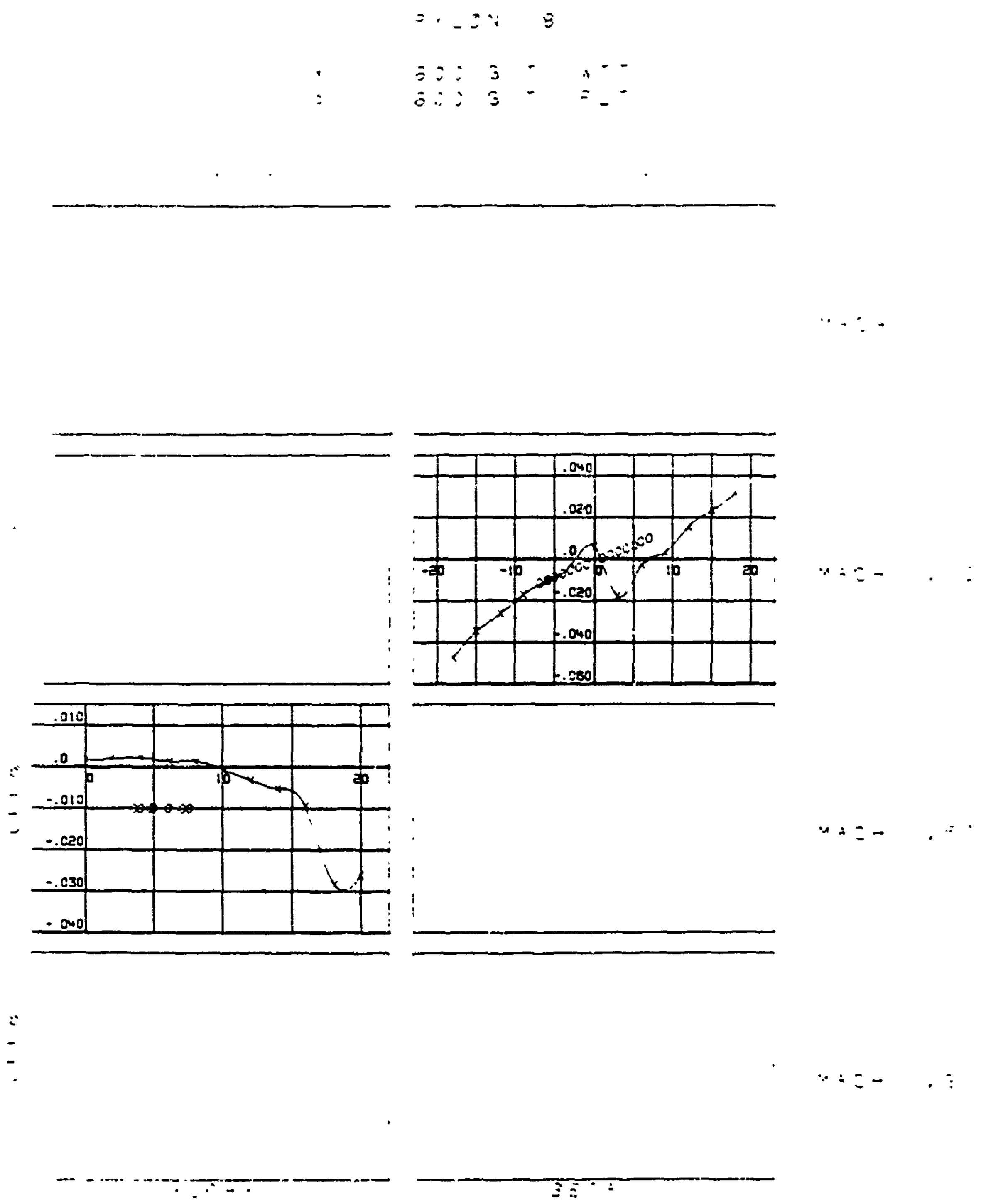


Figure 128. Wind Tunnel Versus 80% Loads Flight Test, Pylon 8, 600-Gallon Tank, CLL

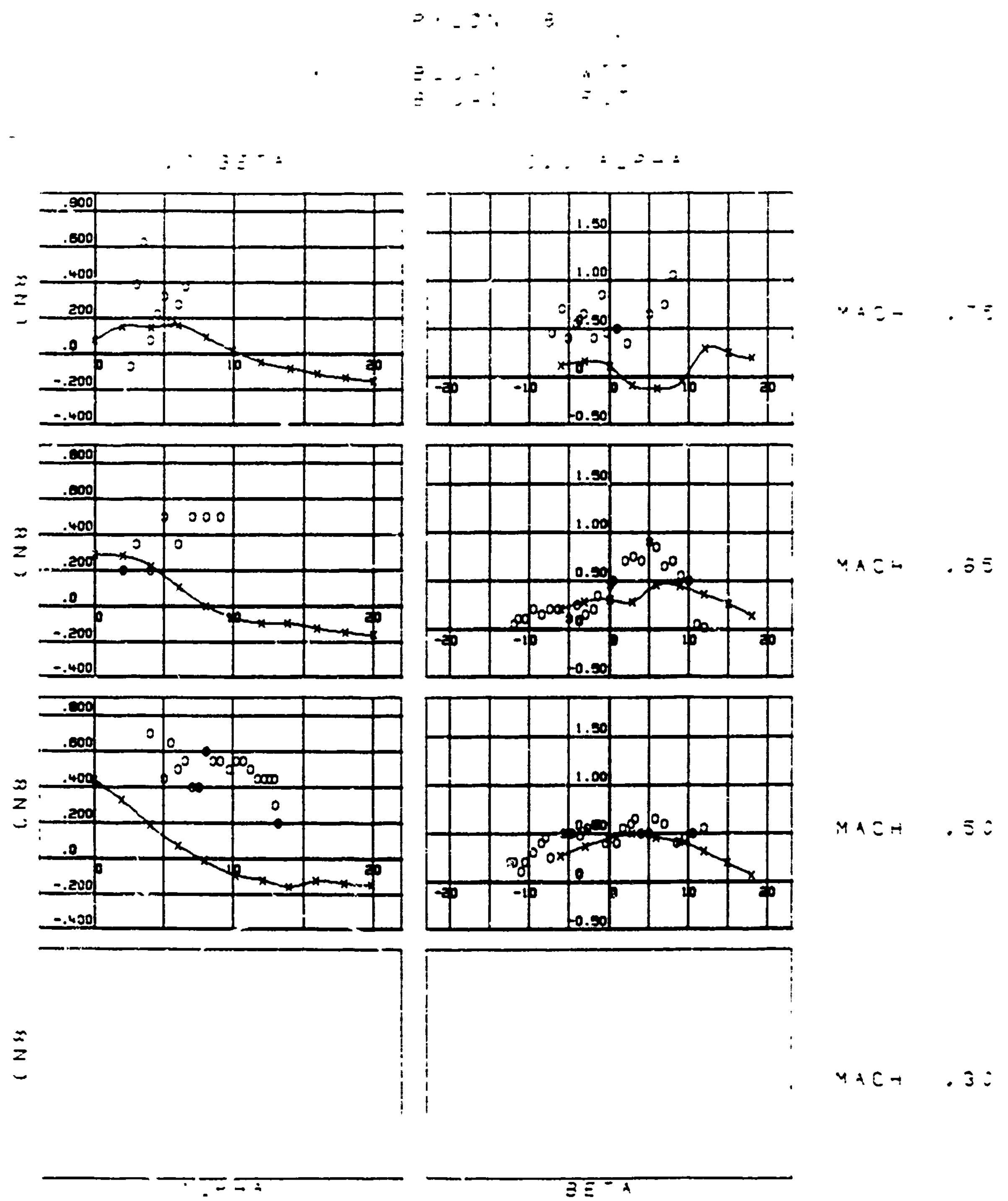


Figure 129. Wind Tunnel Versus 80% Loads Flight Test,
Pylon 8, BLU-1 (U), CN

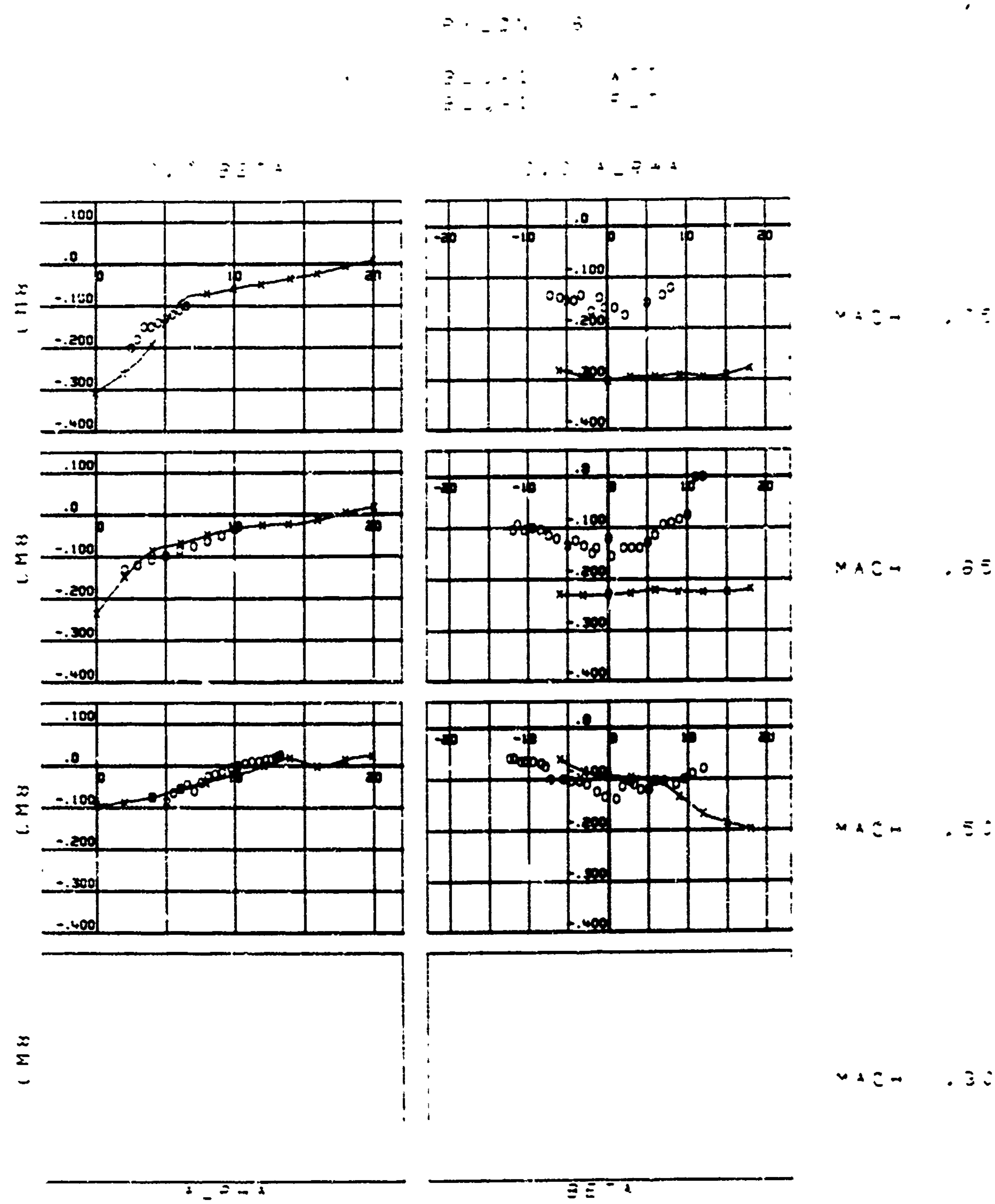


Figure 130. Wind Tunnel Versus 80% Loads Flight Test,
Pylon 8, BLU-1 (U), CM

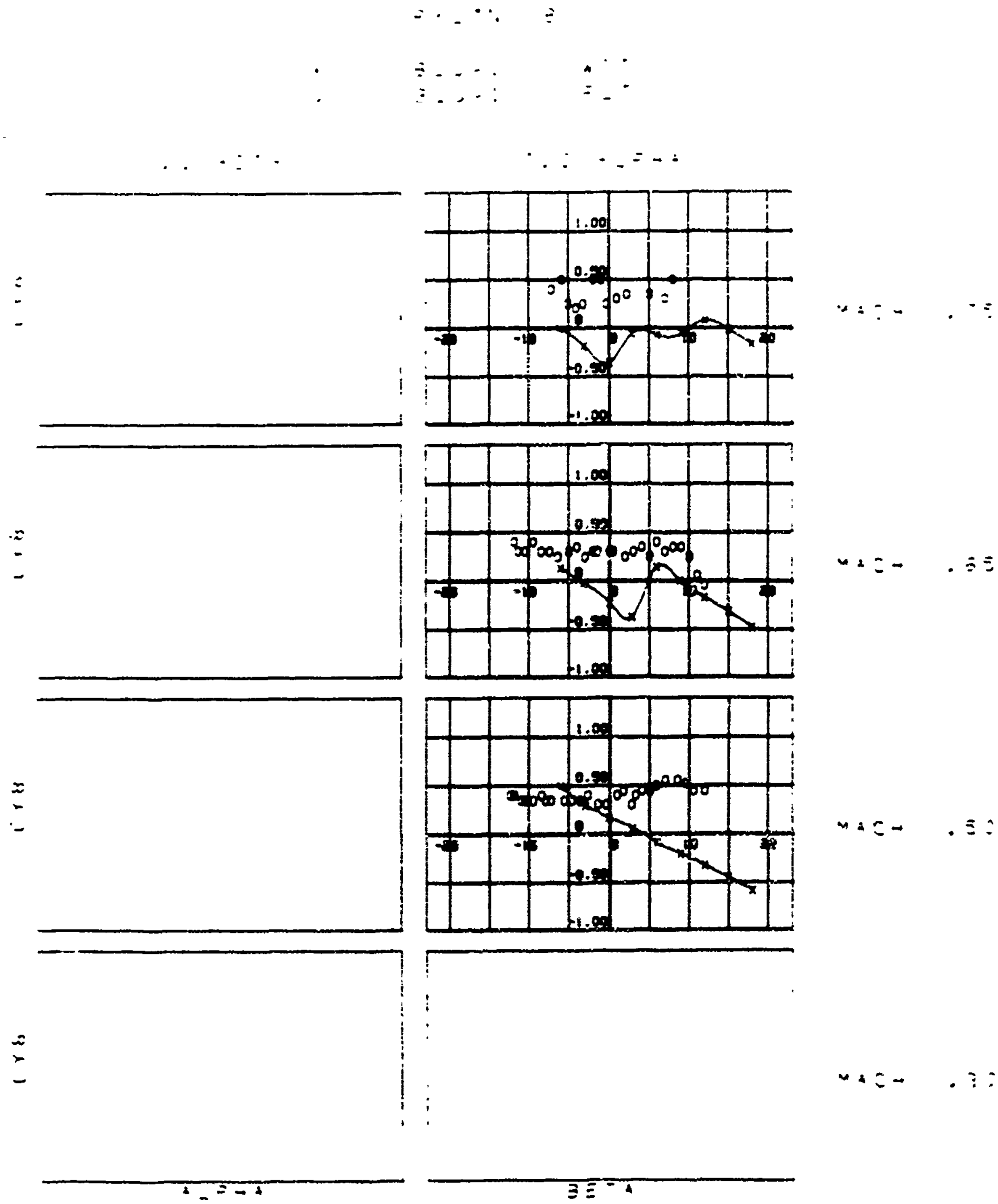


Figure 131. Wind Tunnel Versus 80% Loads Flight Test, Pylon 8, BLU-1 (U), CY

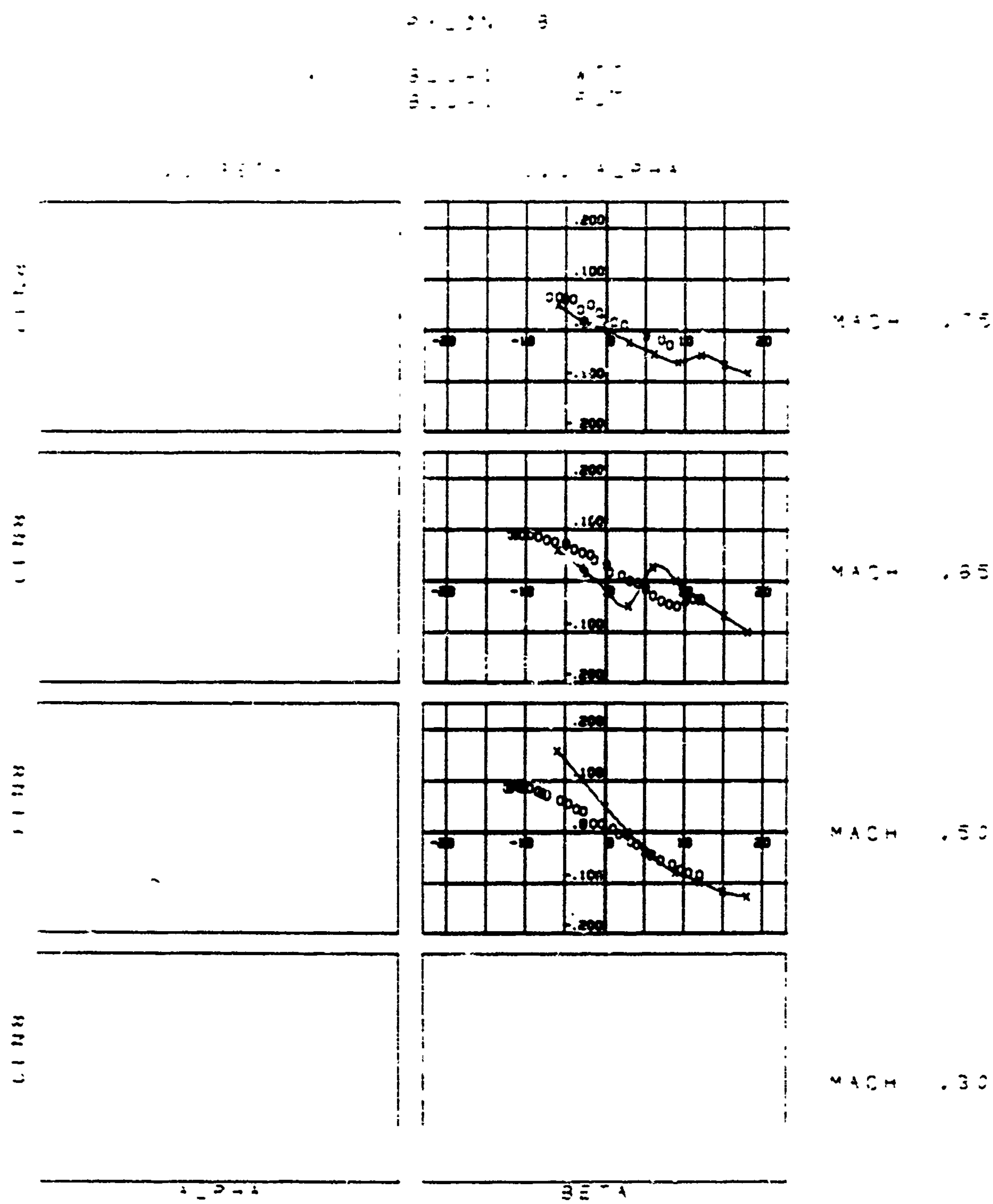


Figure 132. Wind Tunnel Versus 80% Loads Flight Test, Pylon 8, BLU-1 (U), CLN

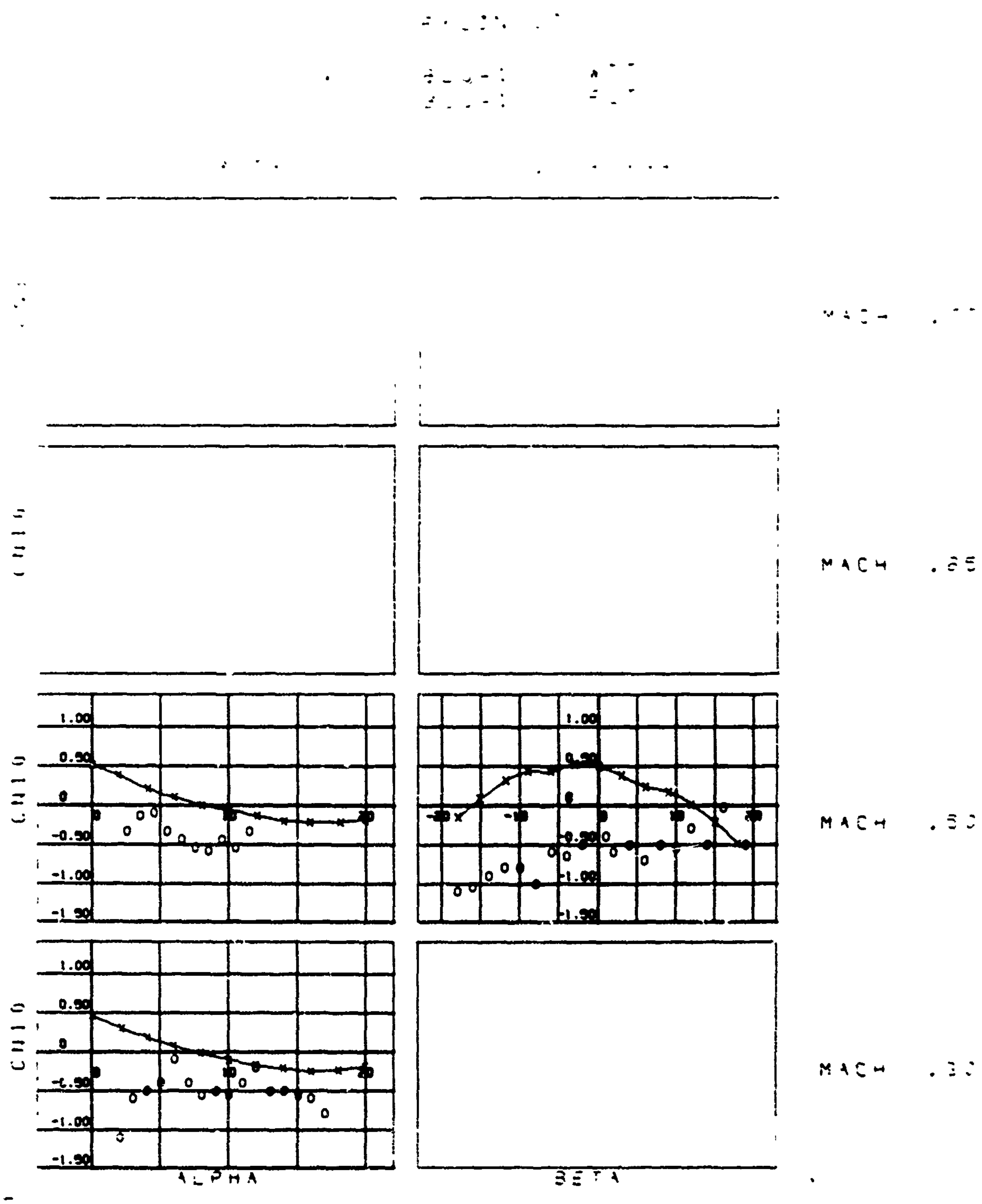


Figure 133. Wind Tunnel Versus 80% Loads Flight Test, Pylon 10, BLU-1 (U), CM

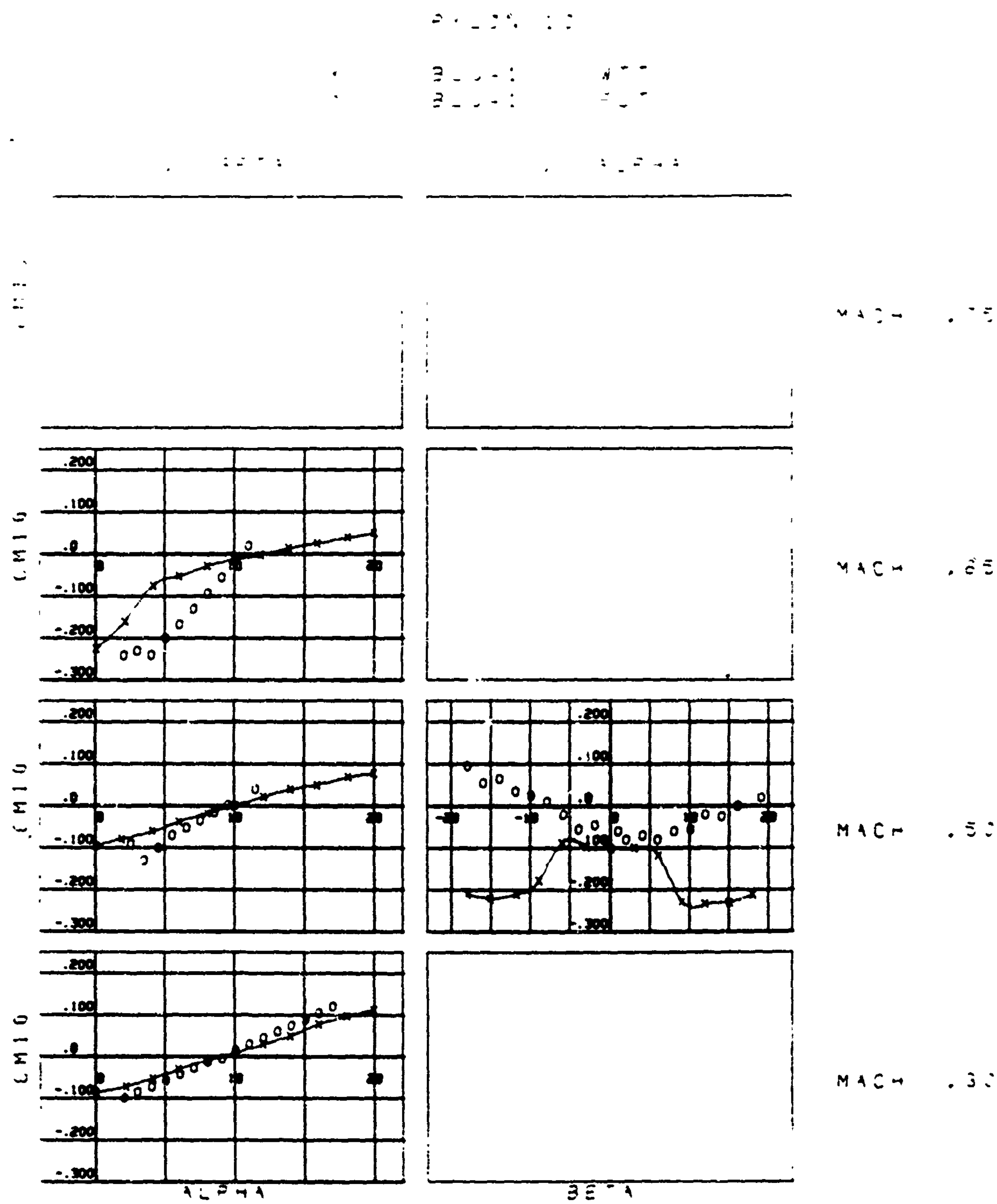


Figure 134. Wind Tunnel Versus 80% Loads Flight Test, Pylon 10, BLU-1 (U), CM

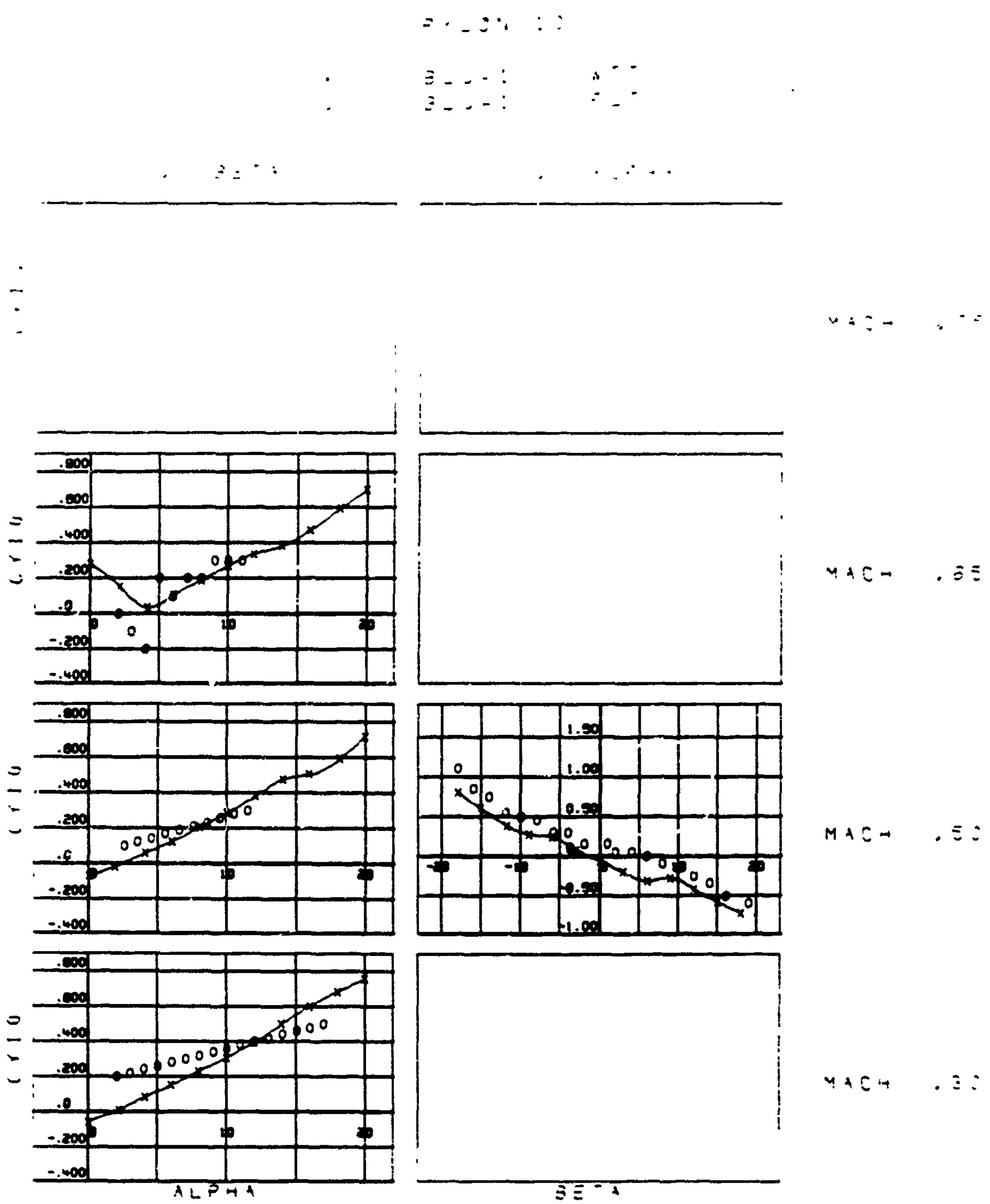


Figure 135. Wind Tunnel Versus 80% Loads Flight Test,
Pylon 10, BLU-1 (U), CY

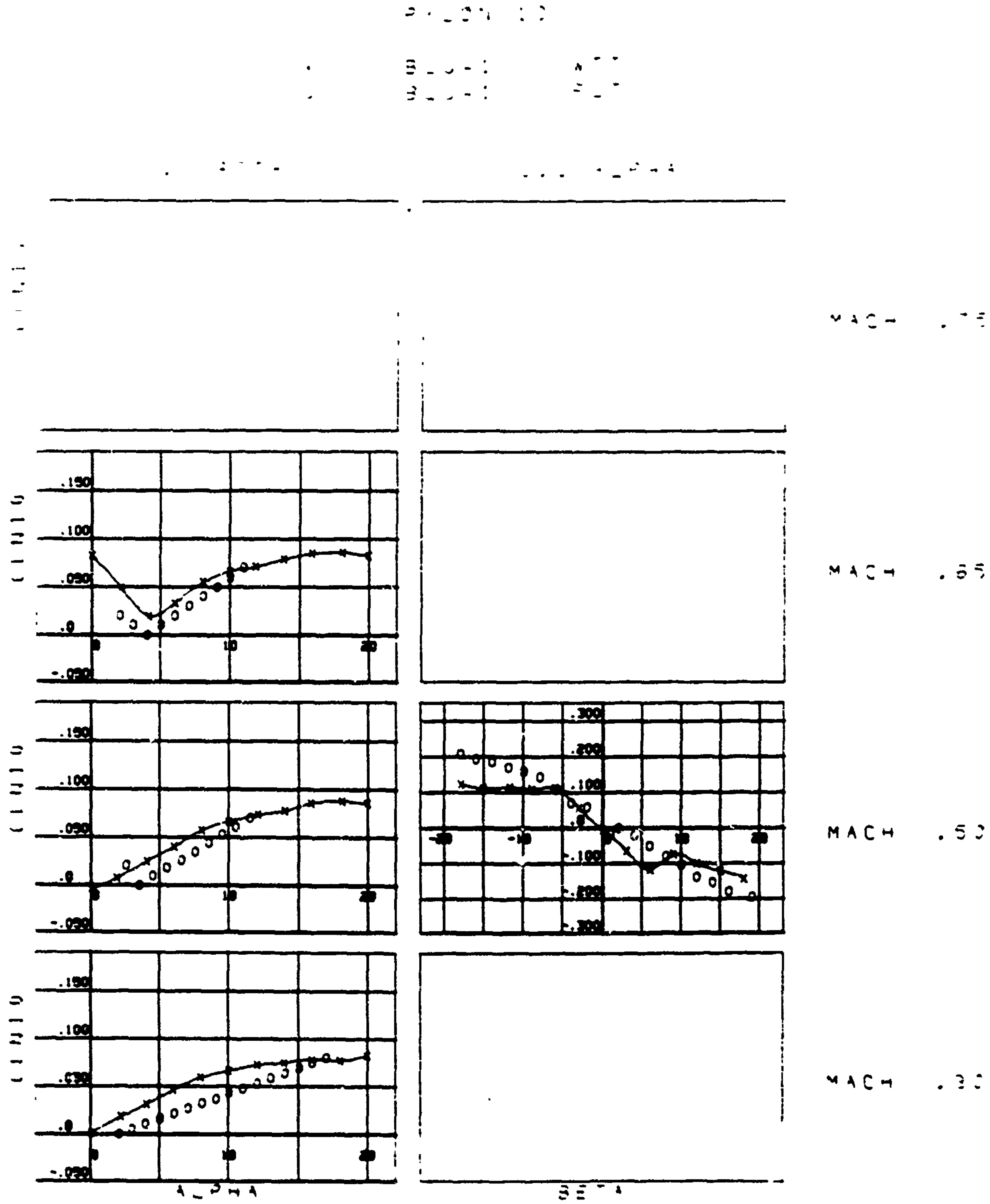


Figure 136. Wind Tunnel Versus 80% Loads Flight Test,
Pylon 10, BLU-1 (U), CLN

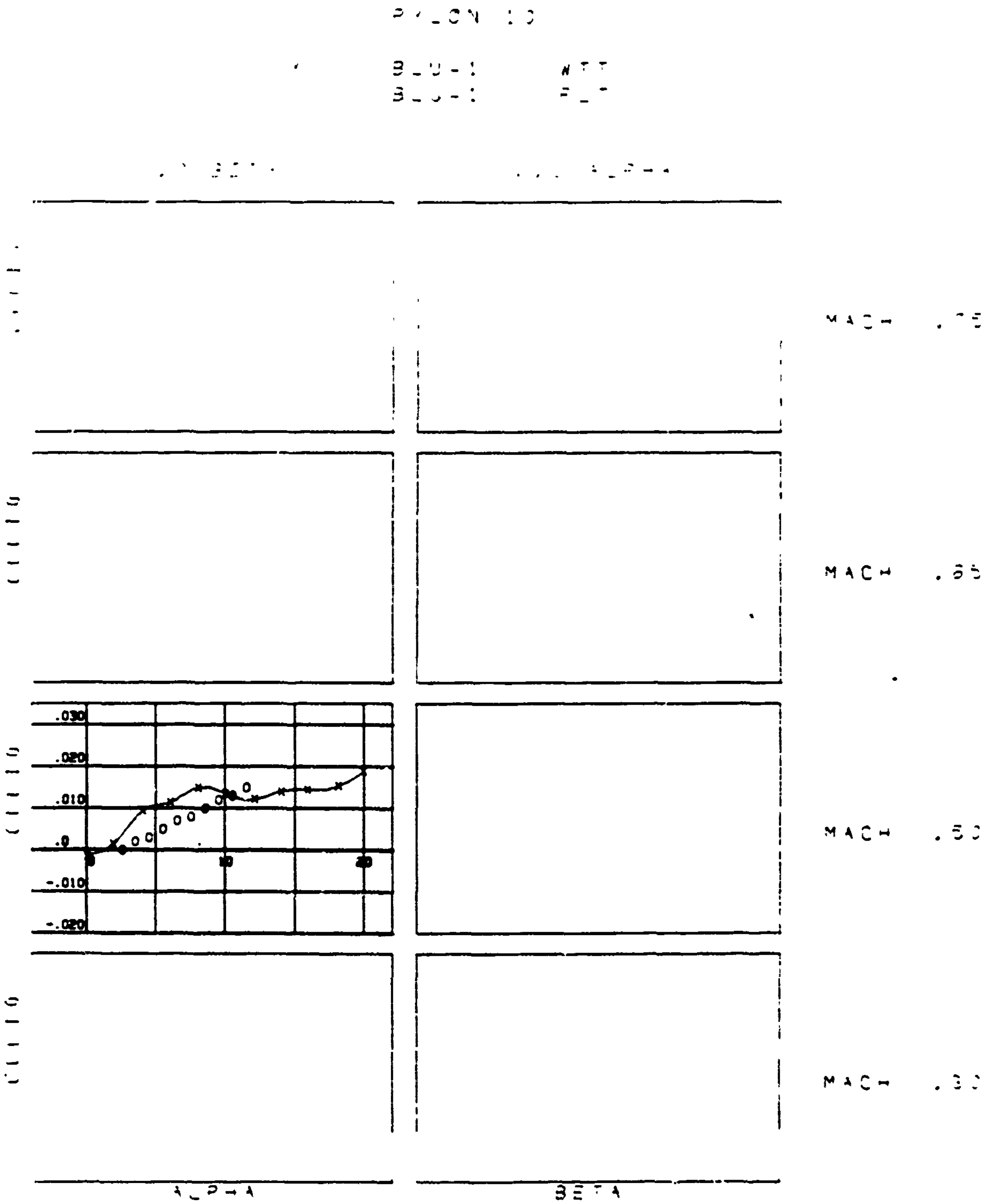


Figure 137. Wind Tunnel Versus 80% Loads Flight Test, Pylon 10, BLU-1 (U), CLL

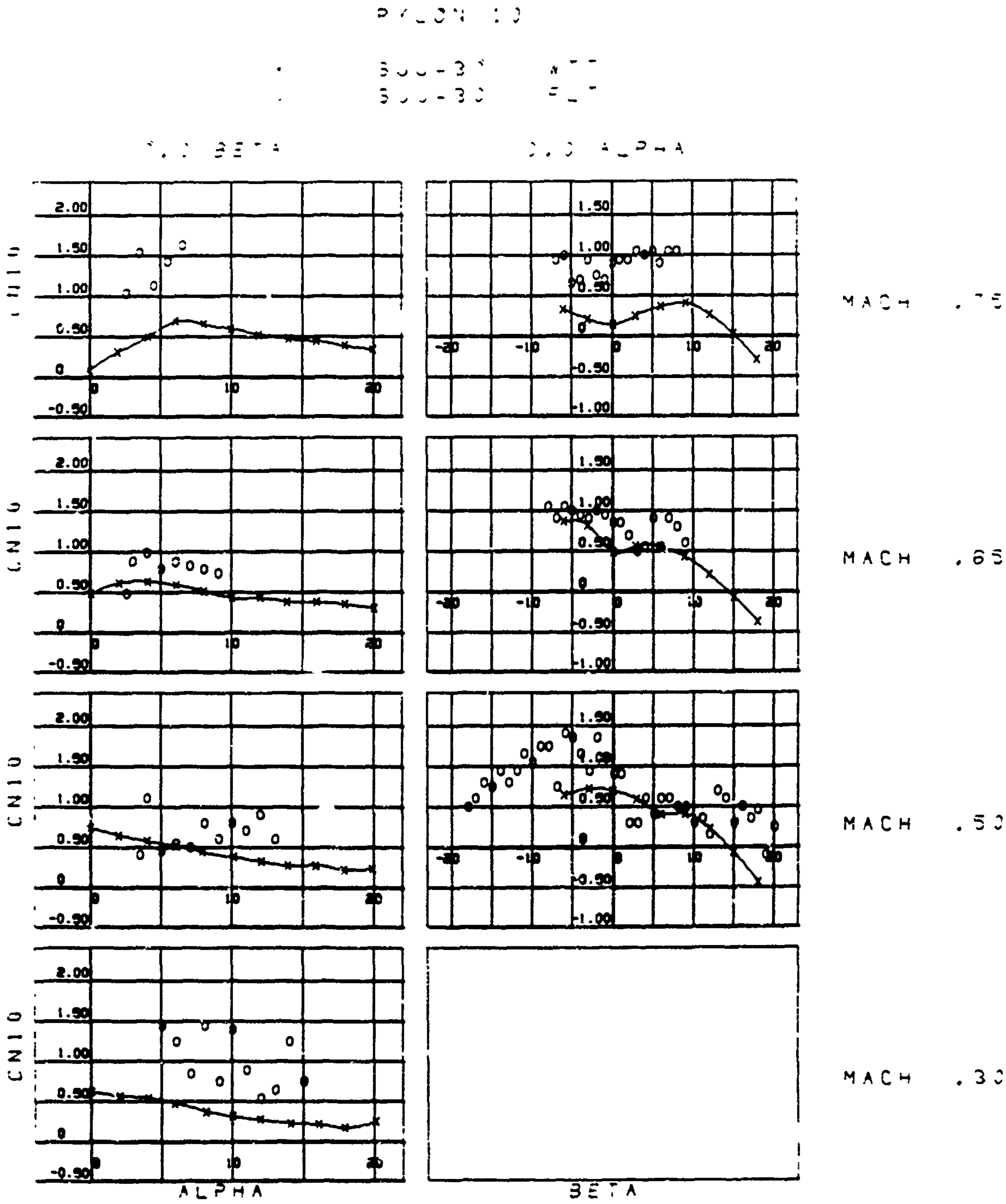


Figure 138. Wind Tunnel Versus 80% Loads Flight Test,
Pylon 10, SUU-30, CN

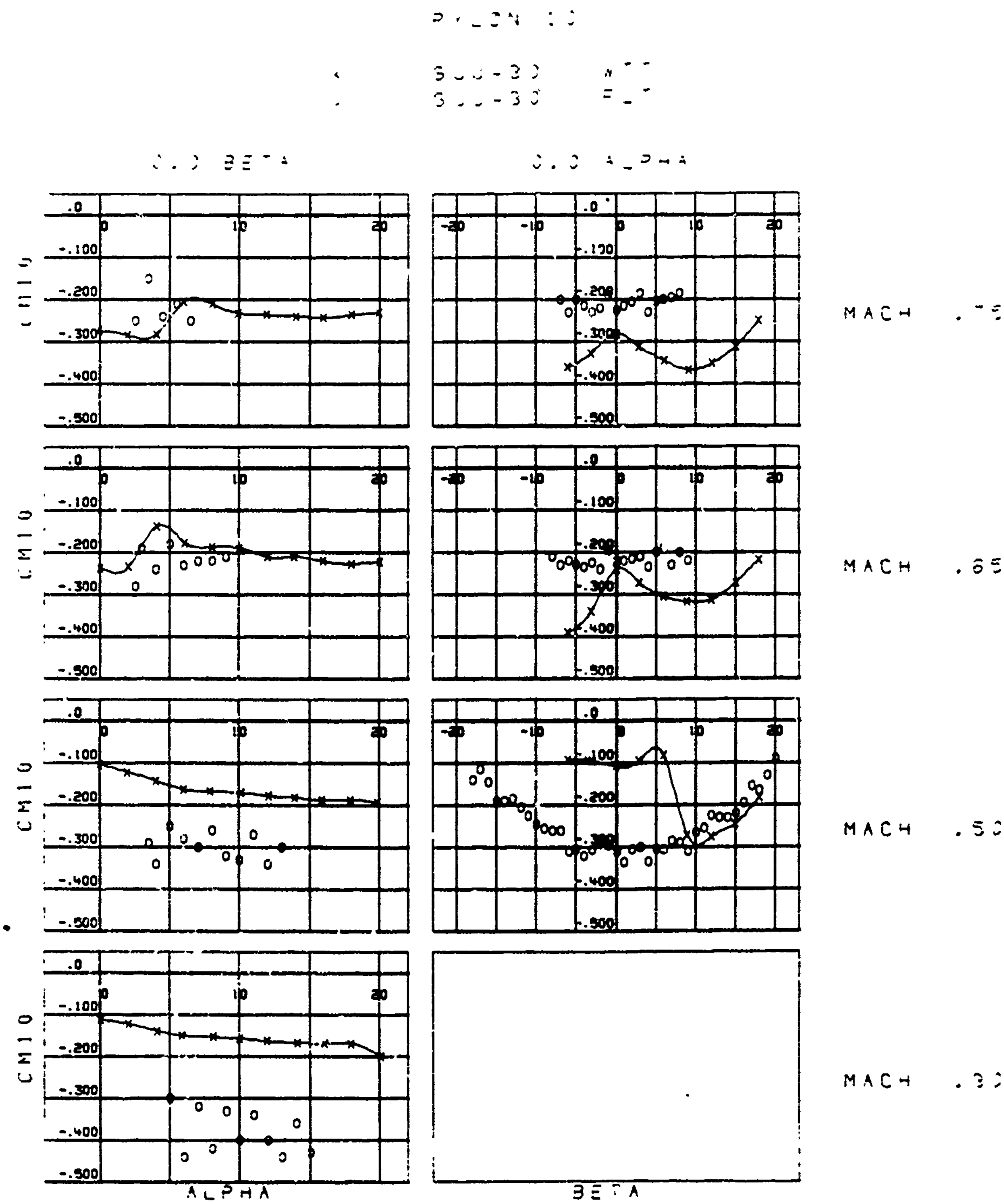


Figure 139. Wind Tunnel Versus 80% Loads Flight Test,
Pylon 10, SUU-30, CM

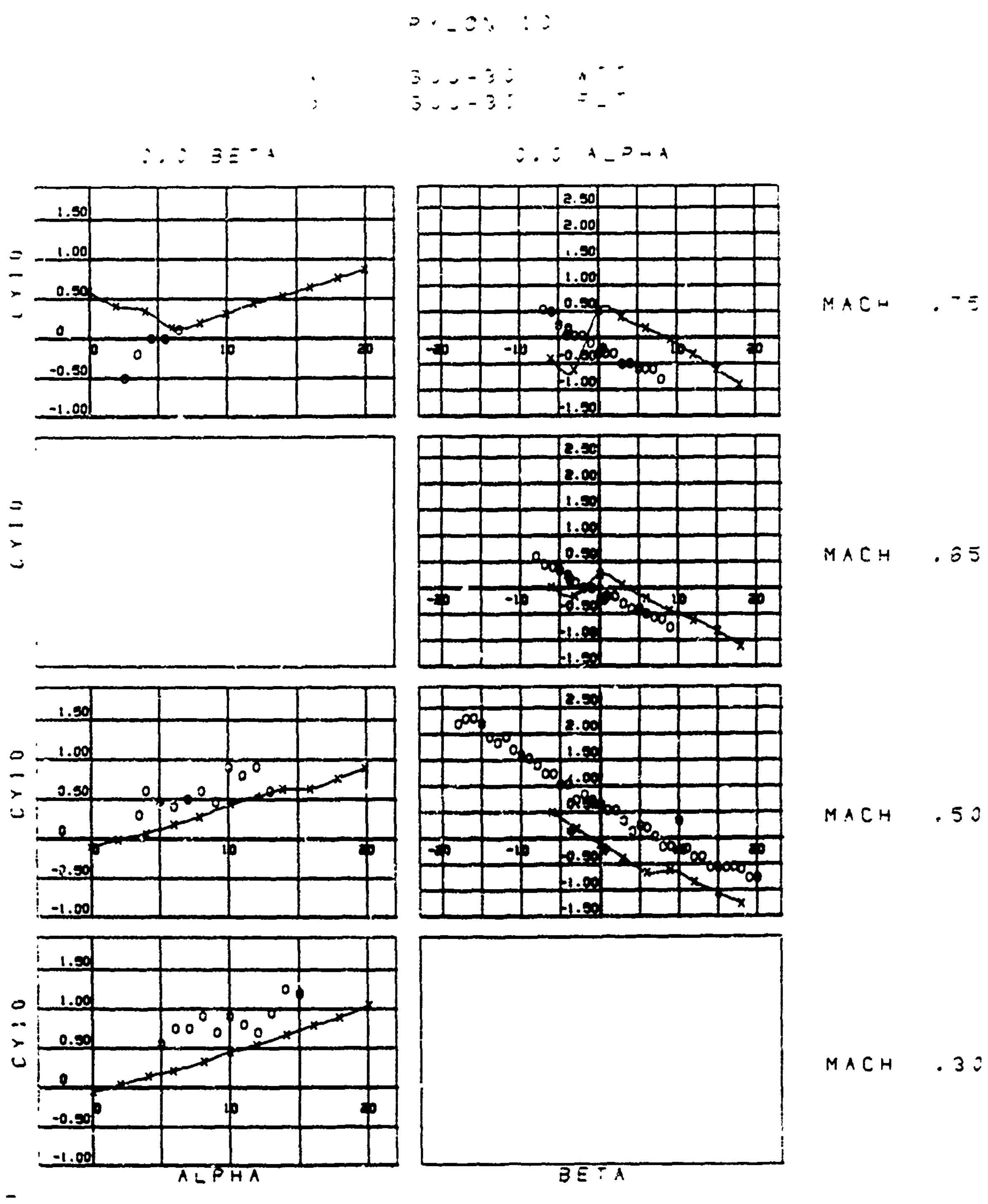


Figure 140. Wind Tunnel Versus 80% Loads Flight Test,
Pylon 10, SUU-30, CY

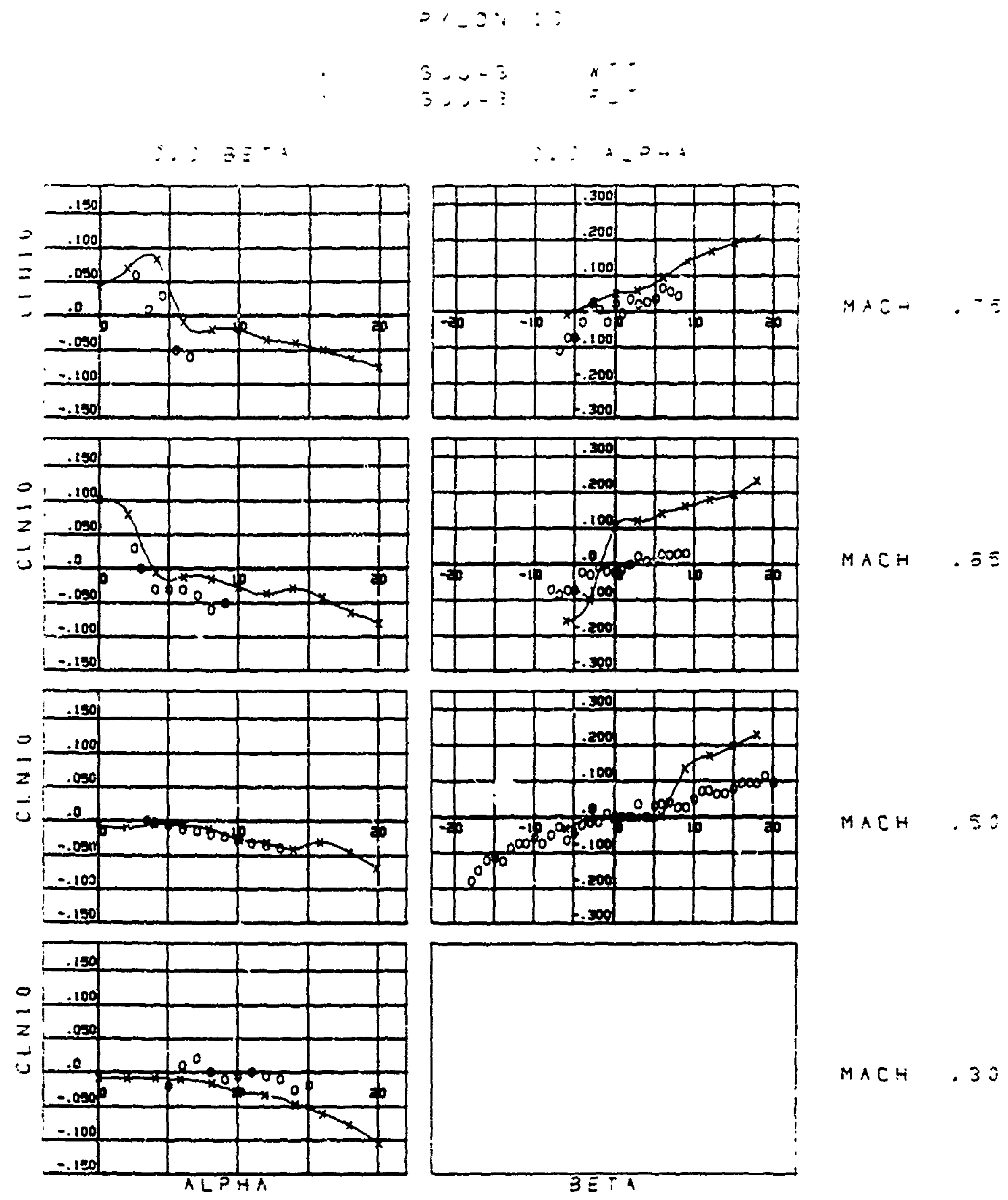


Figure 141. Wind Tunnel Versus 80% Loads Flight Test, Pylon 10, SUU-30, CLN

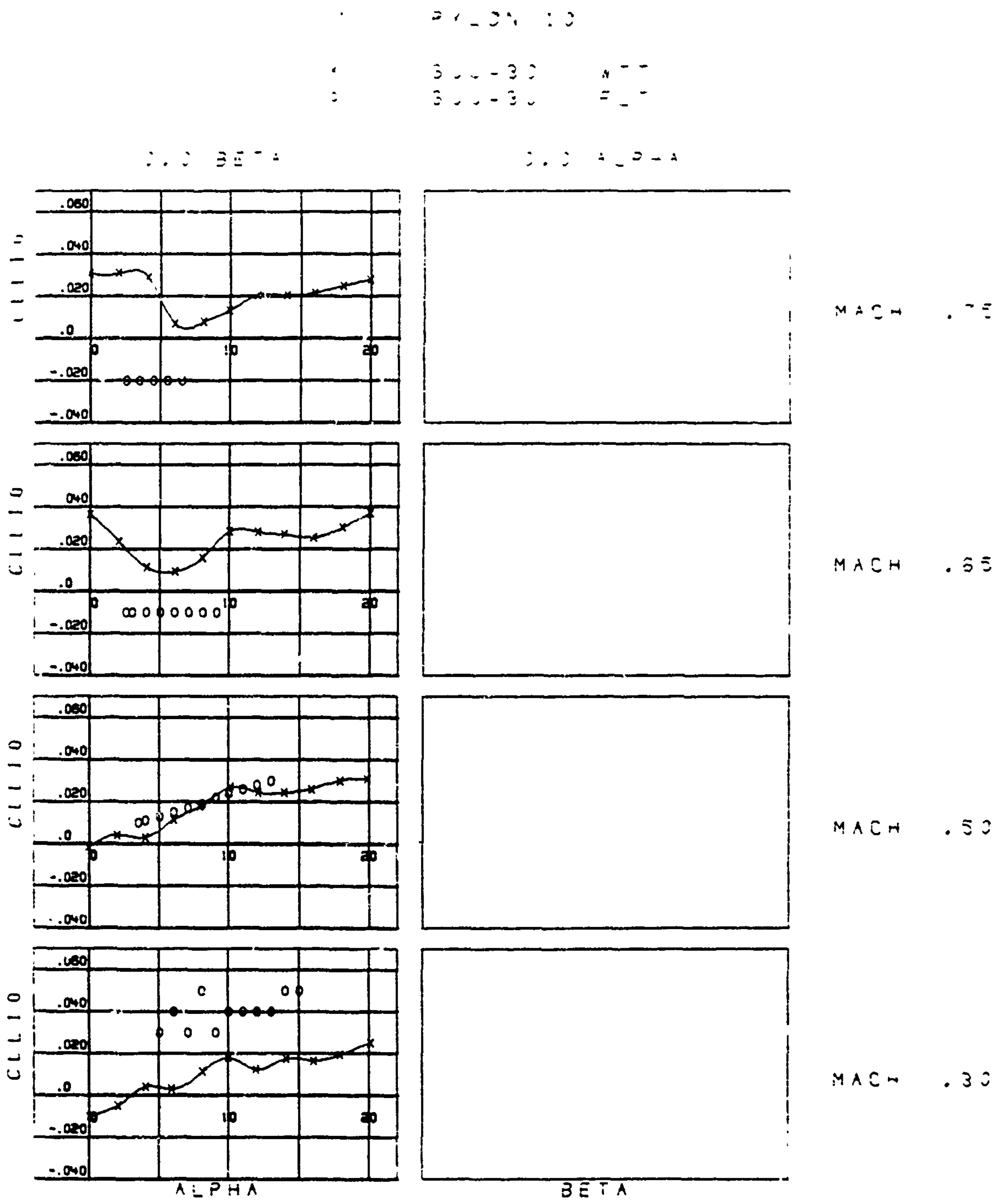


Figure 142. Wind Tunnel Versus 80% Loads Flight Test,
Pylon 10, SUU-30, CLL

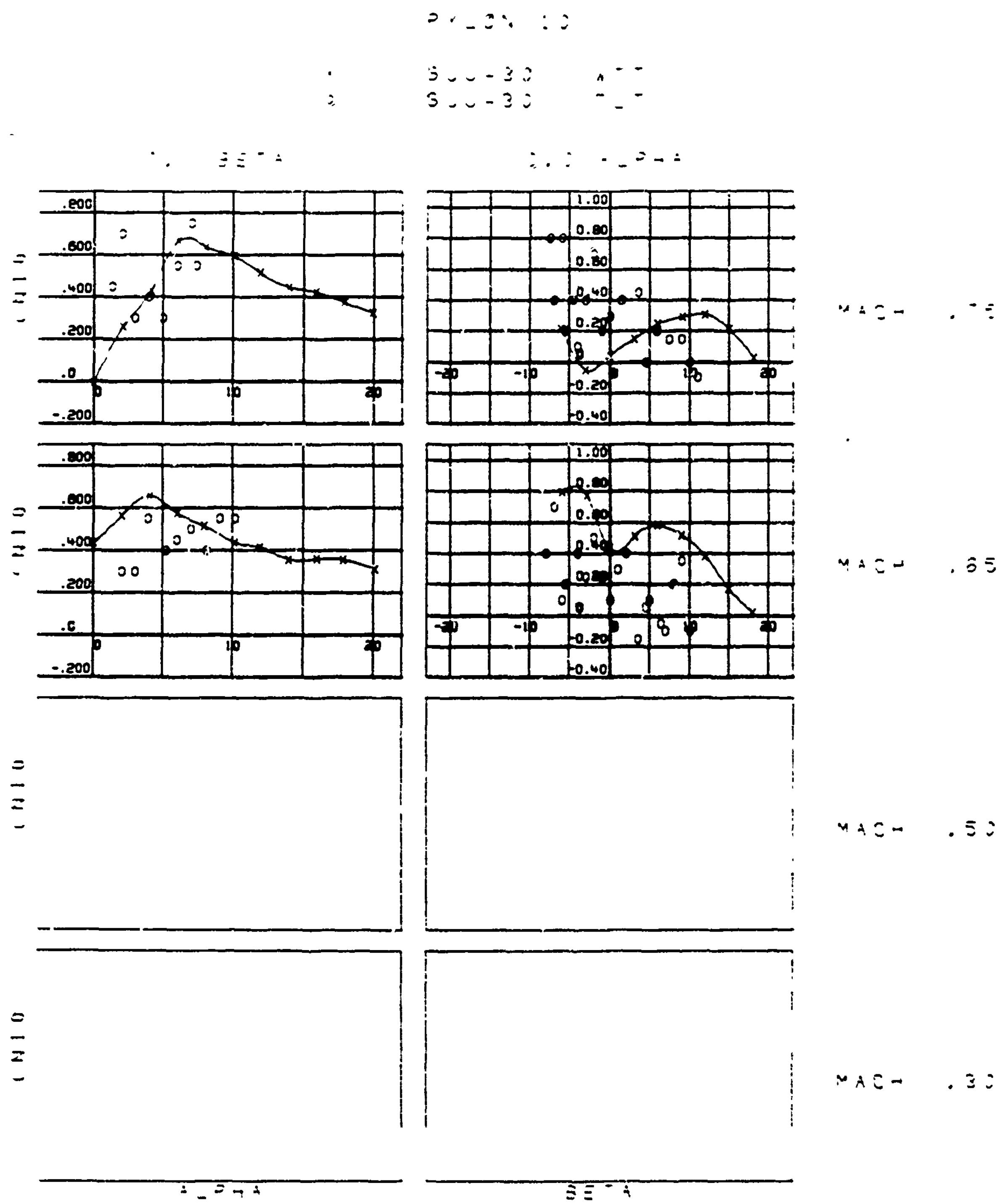


Figure 143. Wind Tunnel Versus 100% Loads Flight Test, Pylon 10, SUU-30, CN

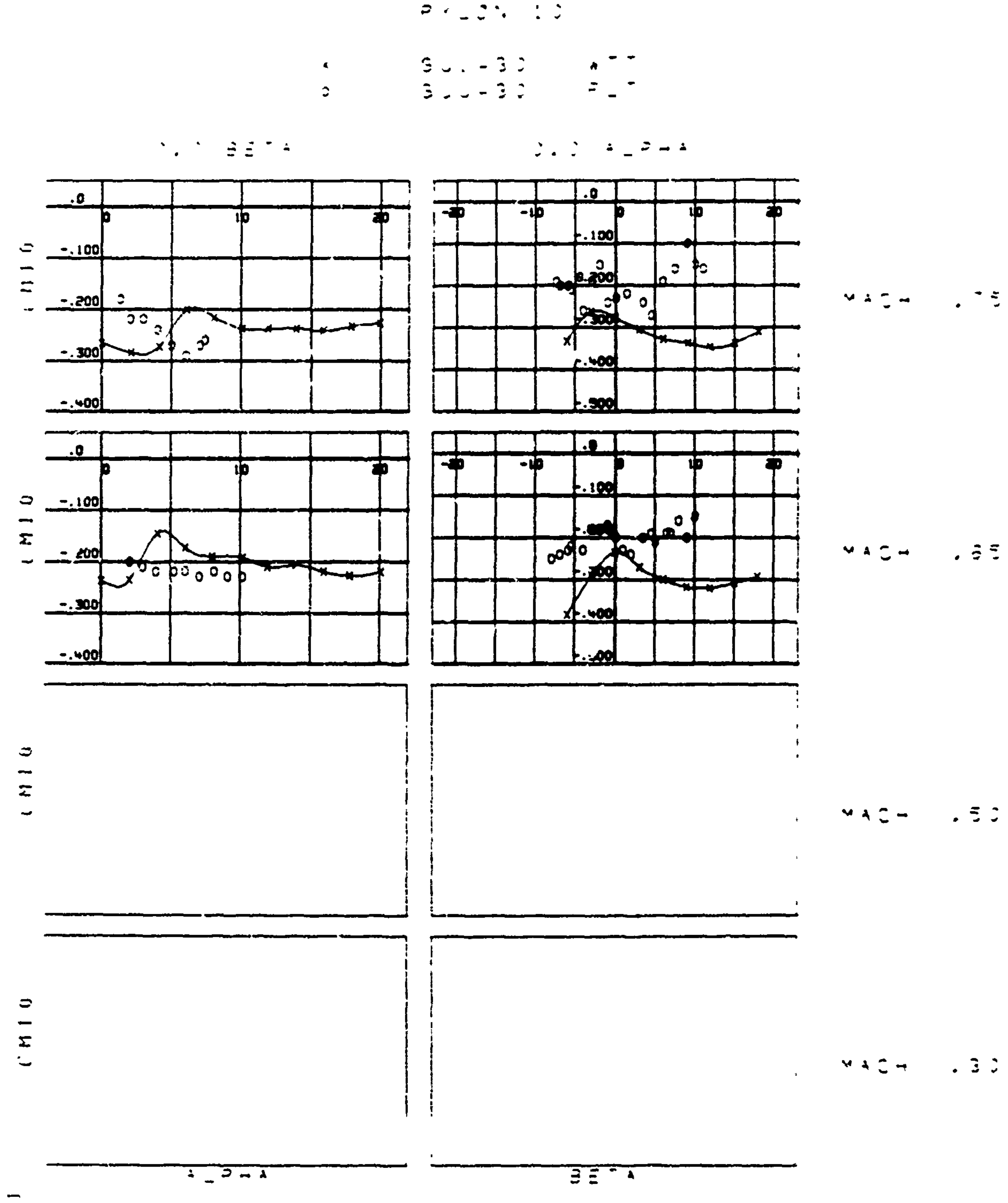


Figure 144. Wind Tunnel Versus 100% Loads Flight Test, Pylon 10, SUU-30, CM

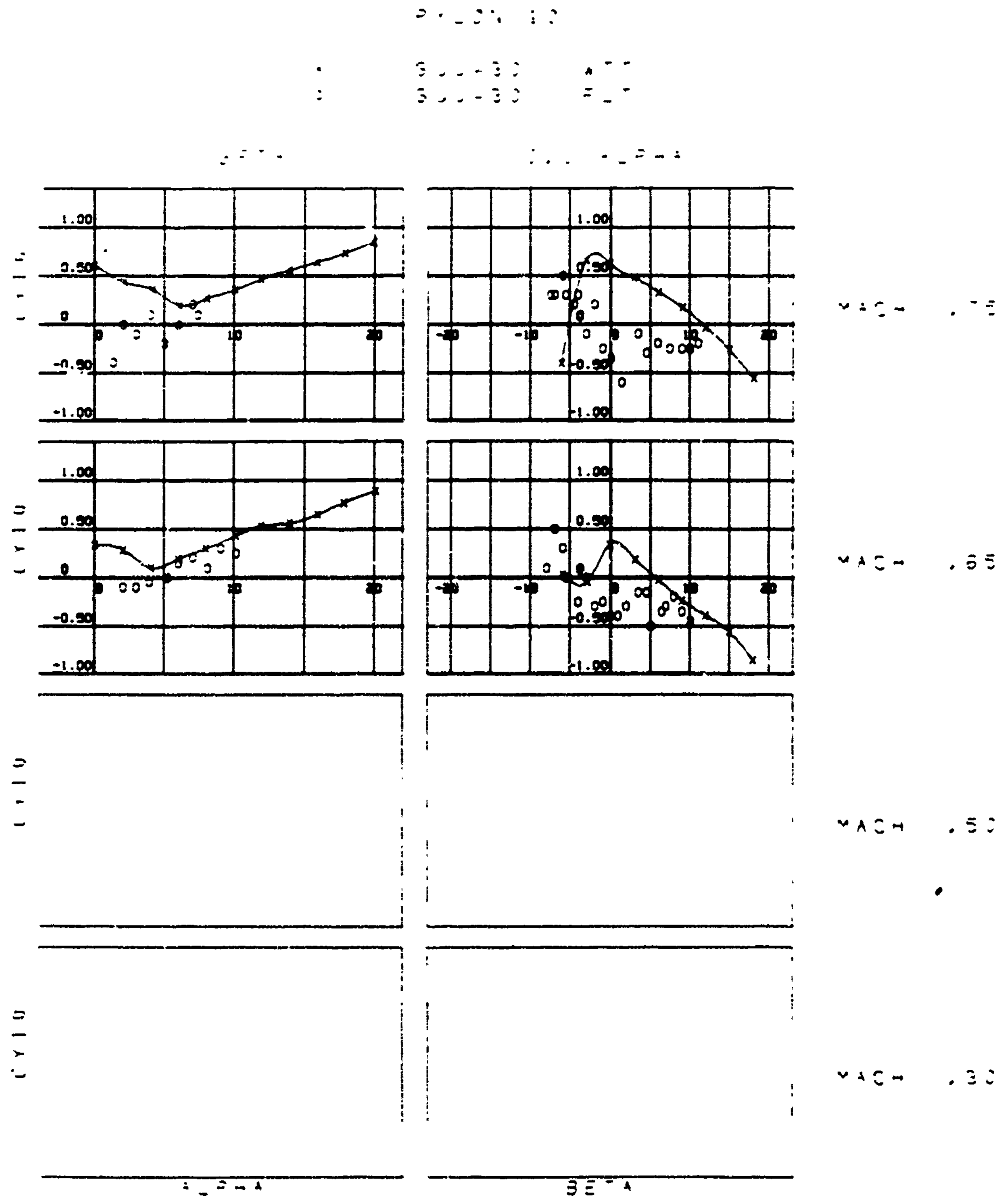


Figure 145. Wind Tunnel Versus 100% Loads Flight Test,
Pylon 10, SUU-30, CY

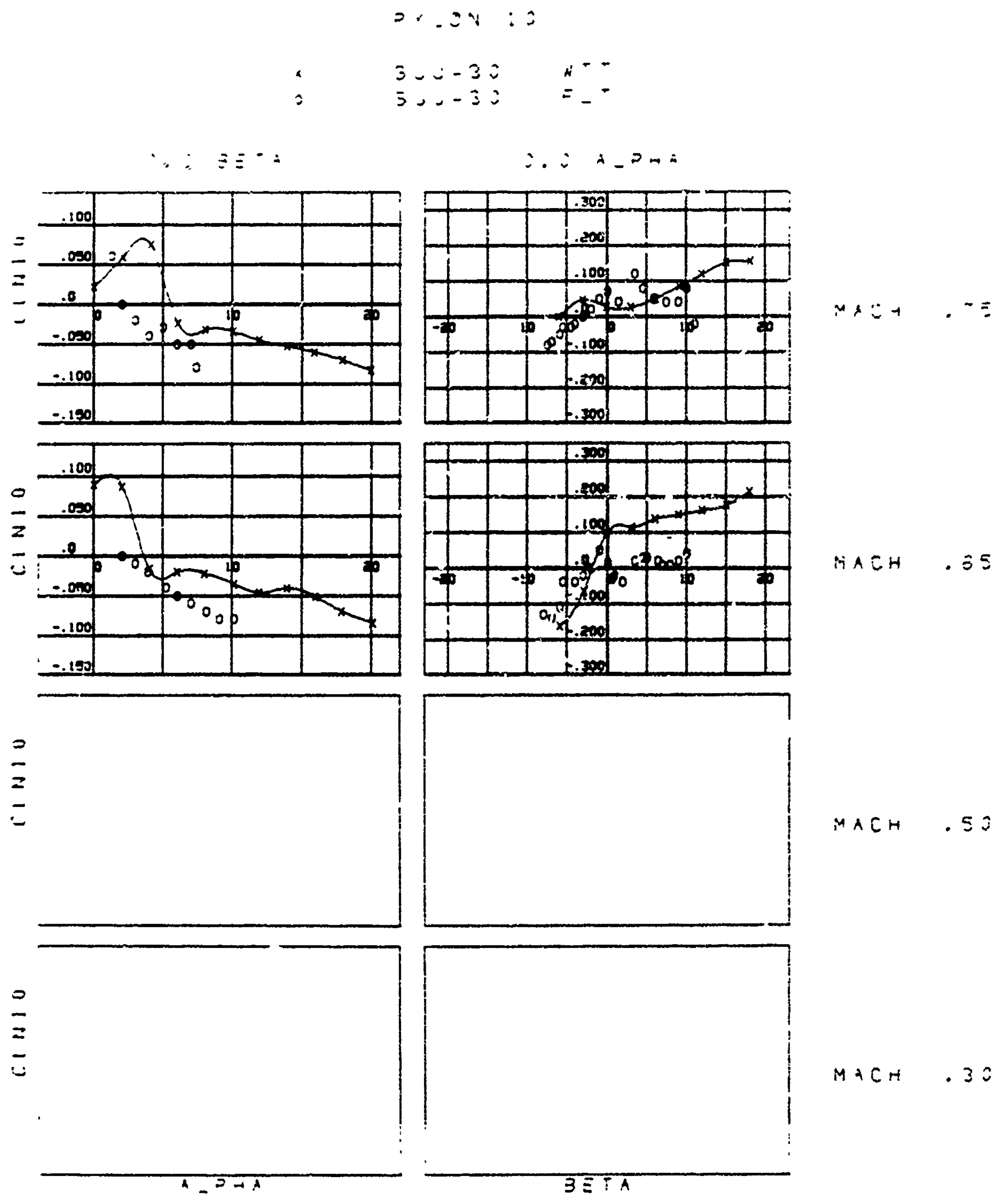


Figure 146. Wind Tunnel Versus 100% Loads Flight Test, Pylon 10, SUU-30, CLN

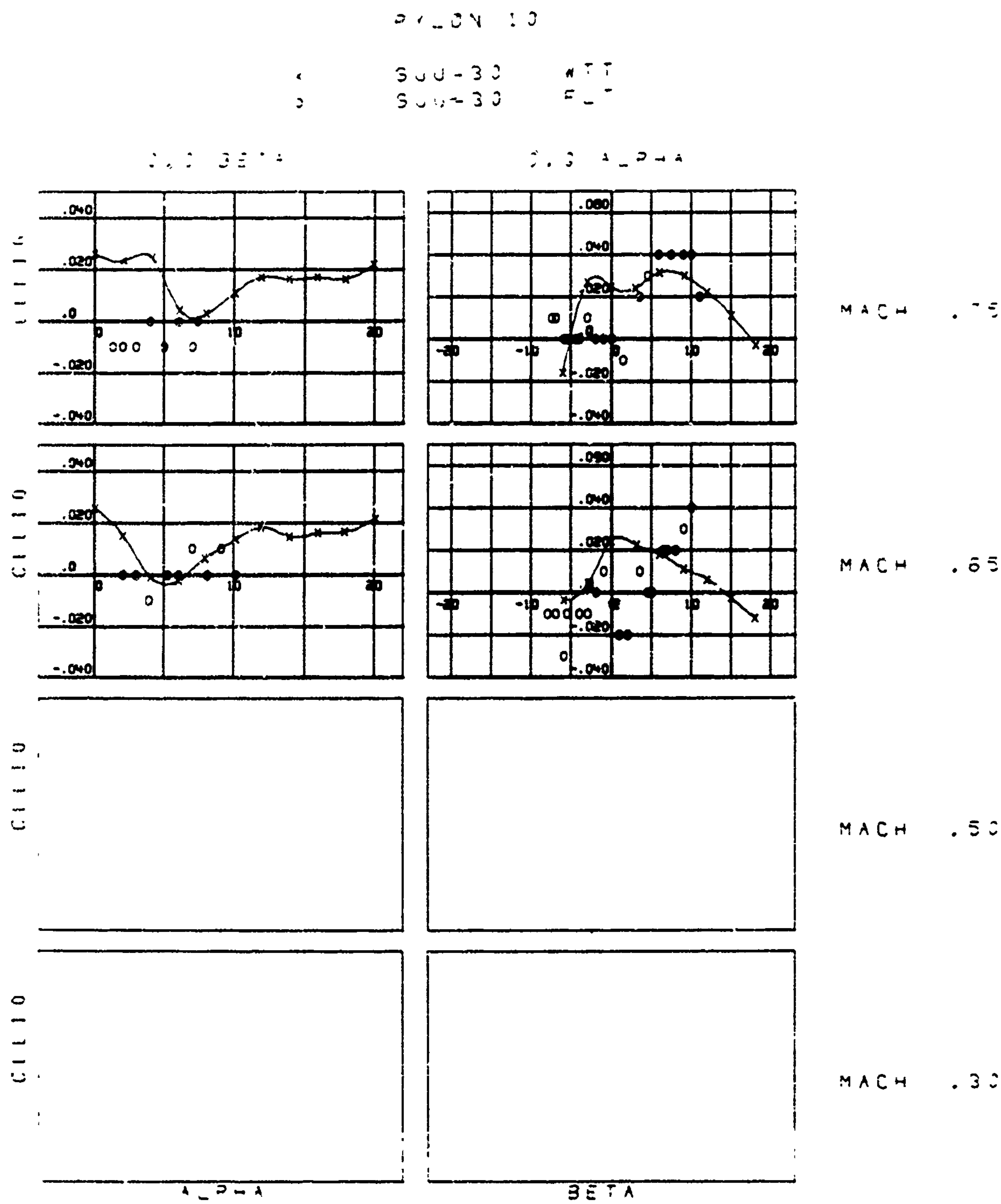


Figure 147. Wind Tunnel Versus 100% Loads Flight Test,
Pylon 10, SUU-30, CLL

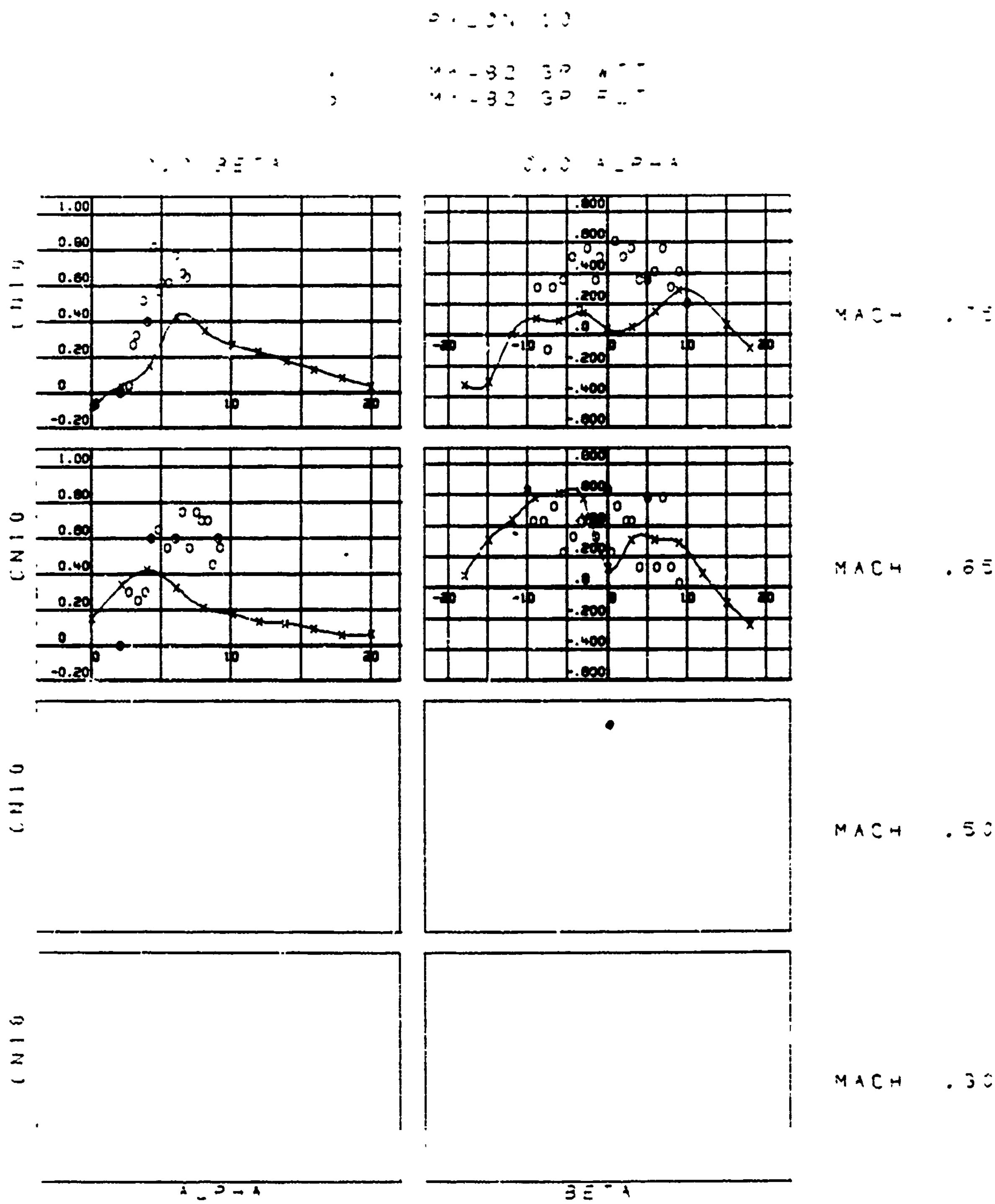


Figure 148. Wind Tunnel Versus 100% Loads Flight Test, Pylon 10, MK-82 GP, CN

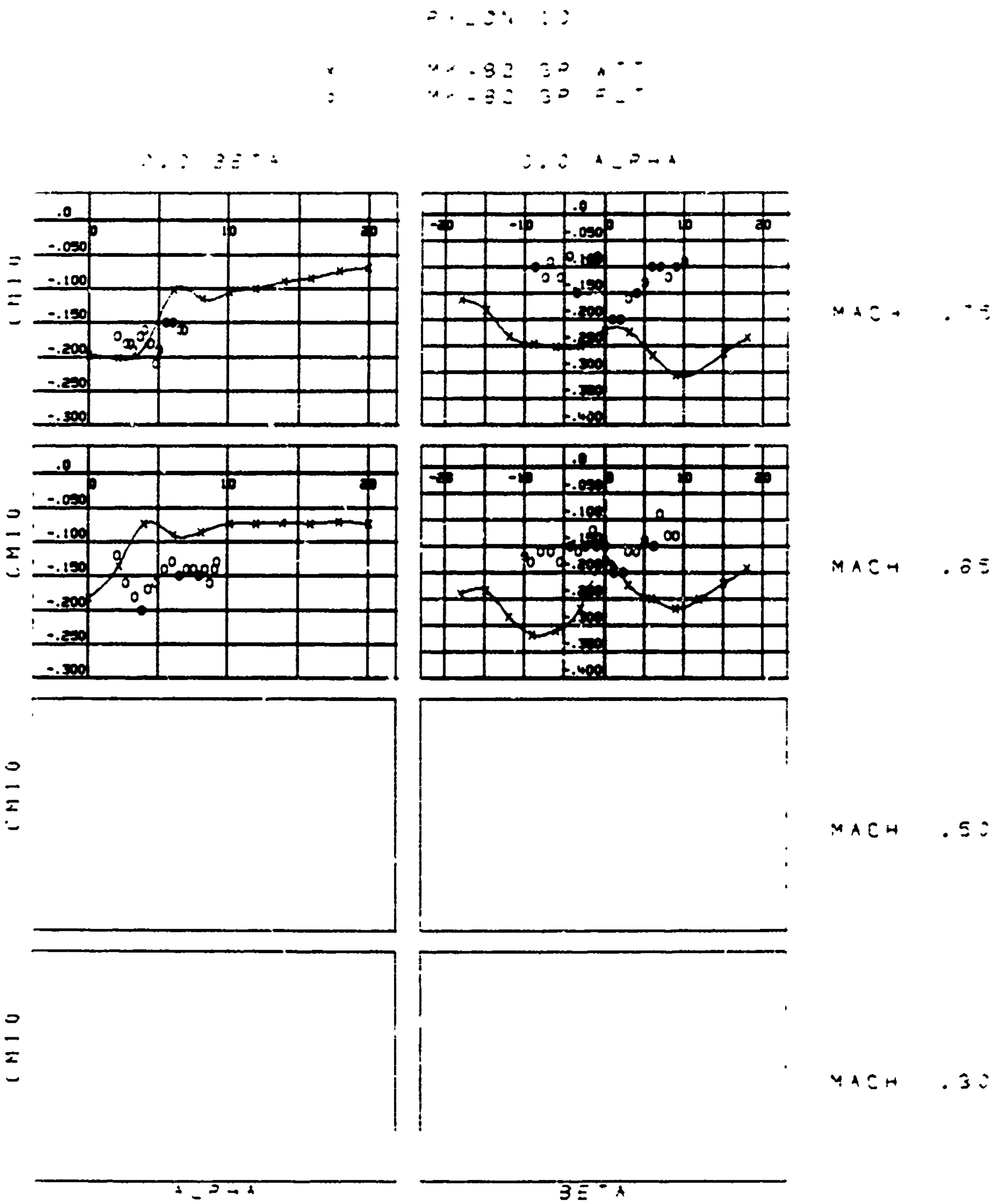


Figure 149. Wind Tunnel Versus 100% Loads Flight Test, Pylon 10, MK-82 GP, CM

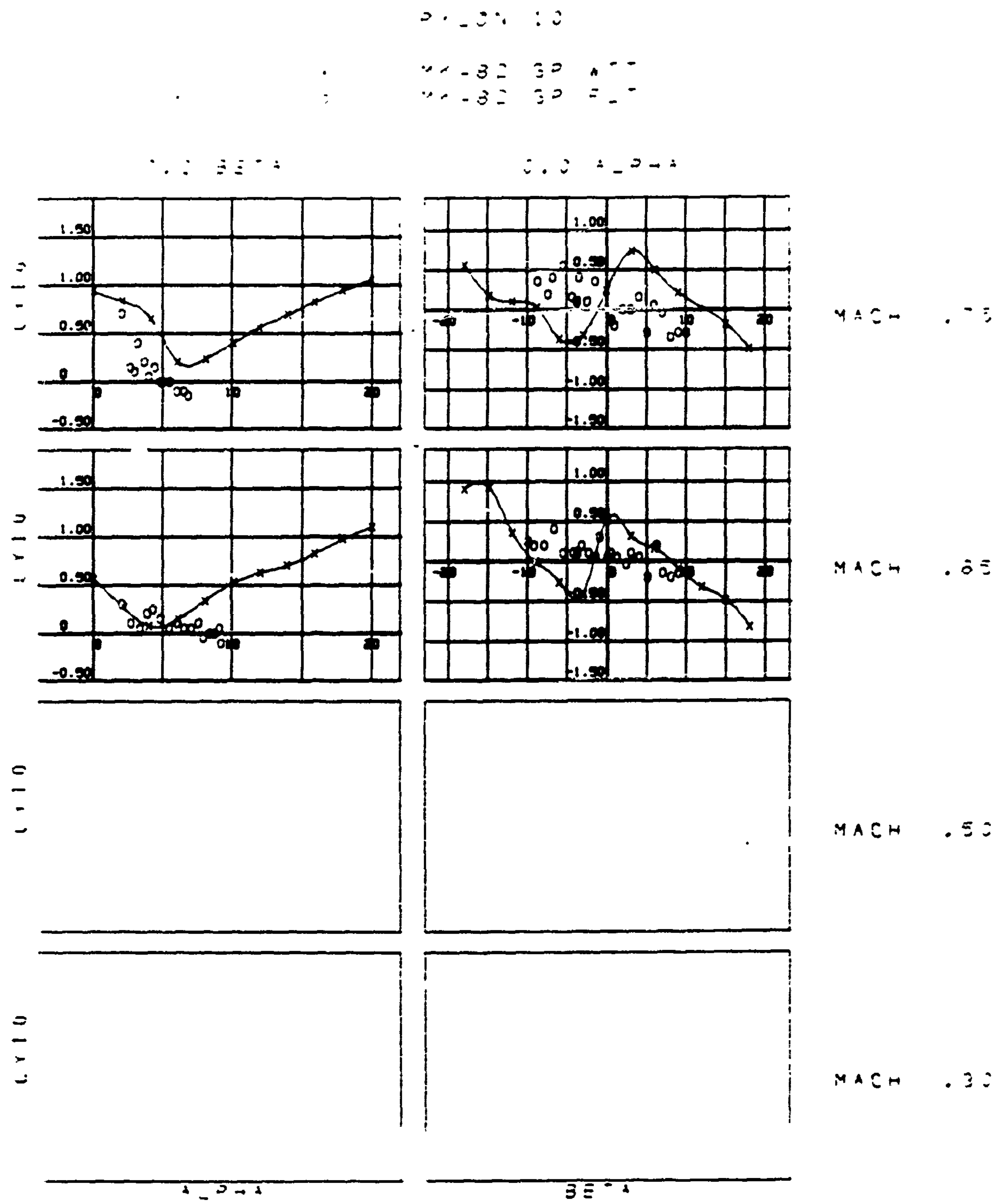


Figure 150. Wind Tunnel Versus 100% Loads Flight Test, Pylon 10, MK-82 GP, CY

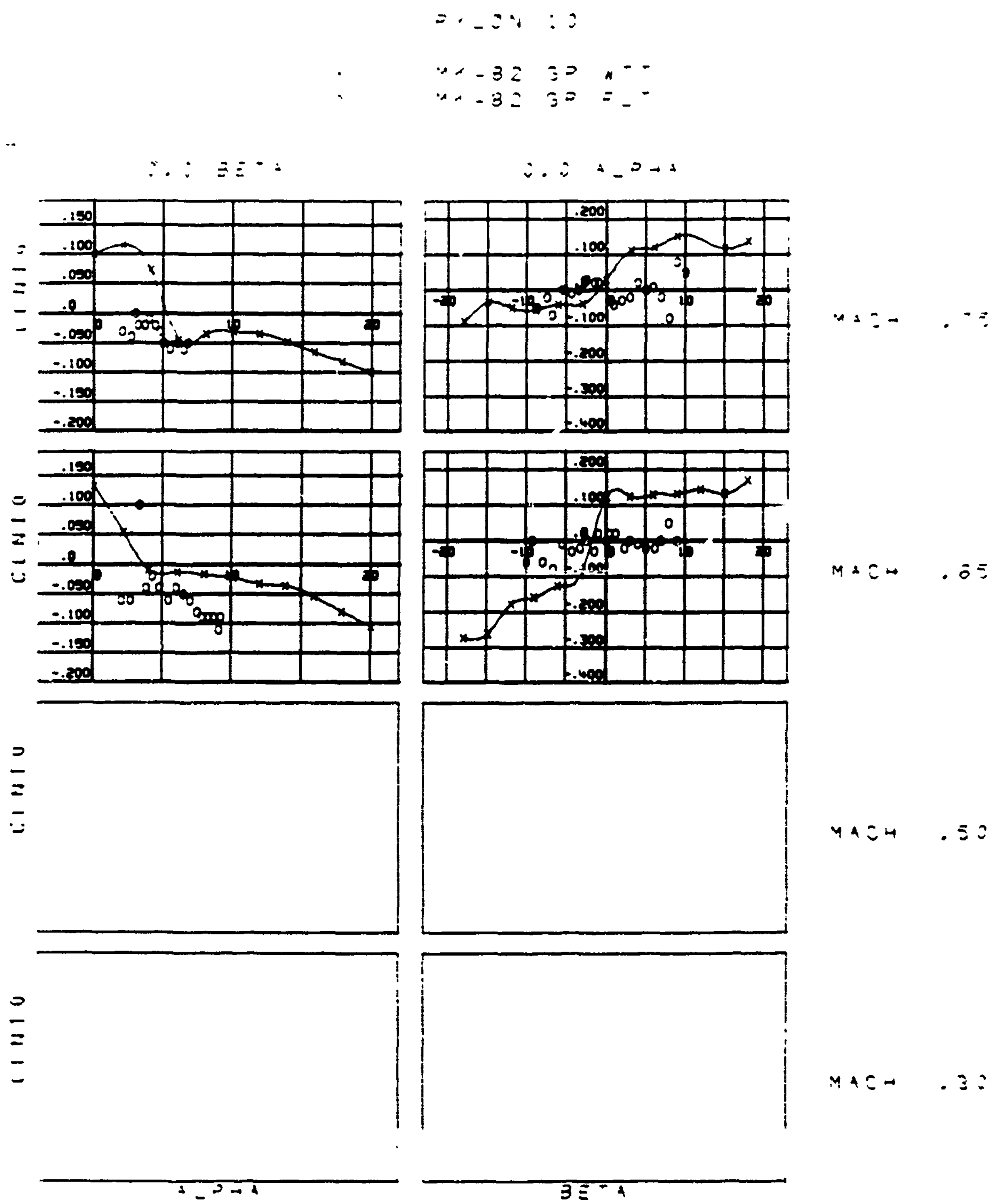


Figure 151. Wind Tunnel Versus 100% Loads Flight Test, Pylon 10, MK-82 GP, CLN

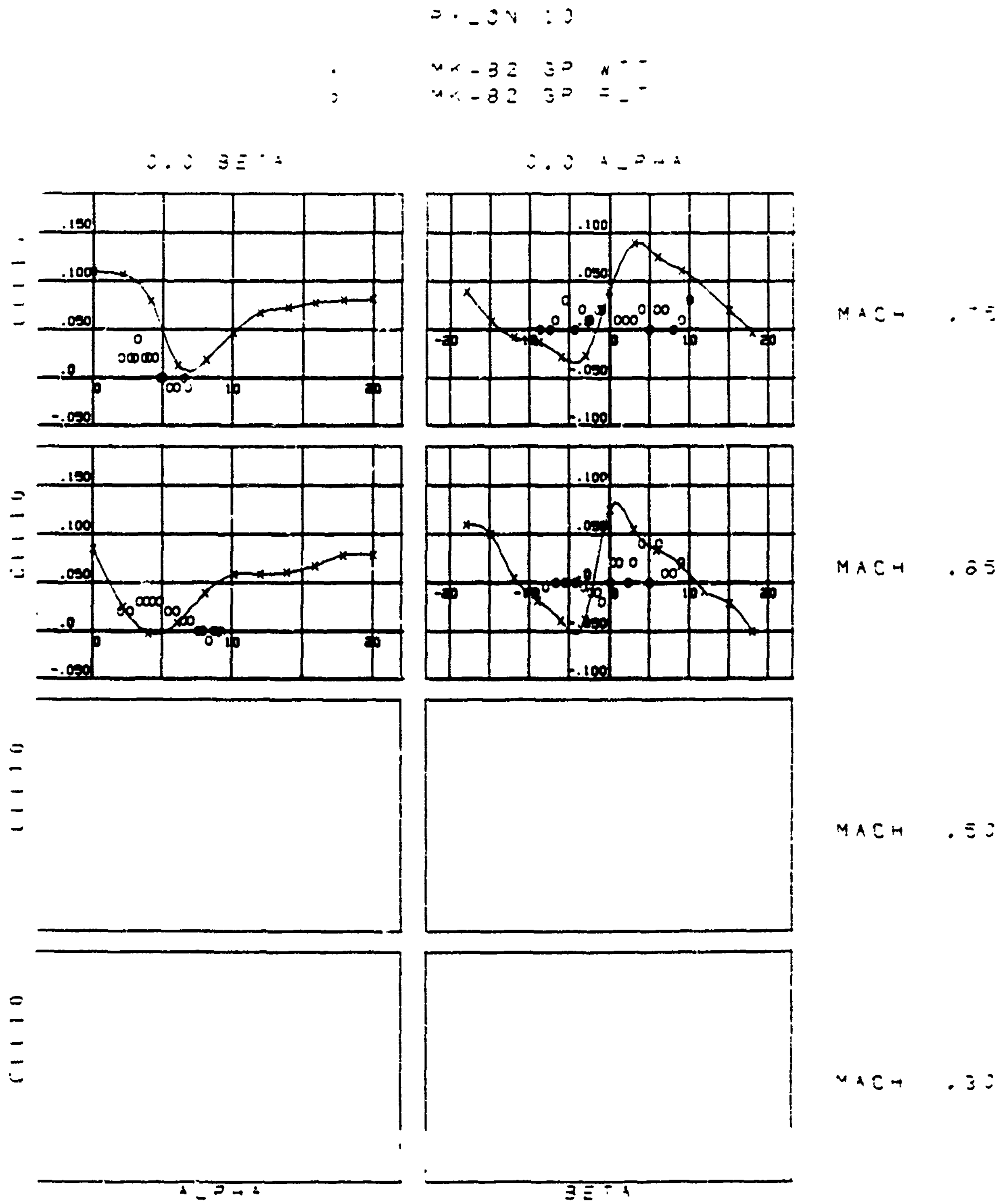


Figure 152. Wind Tunnel Versus 100% Loads Flight Test, Pylon 10, MK-82 GP, CLL

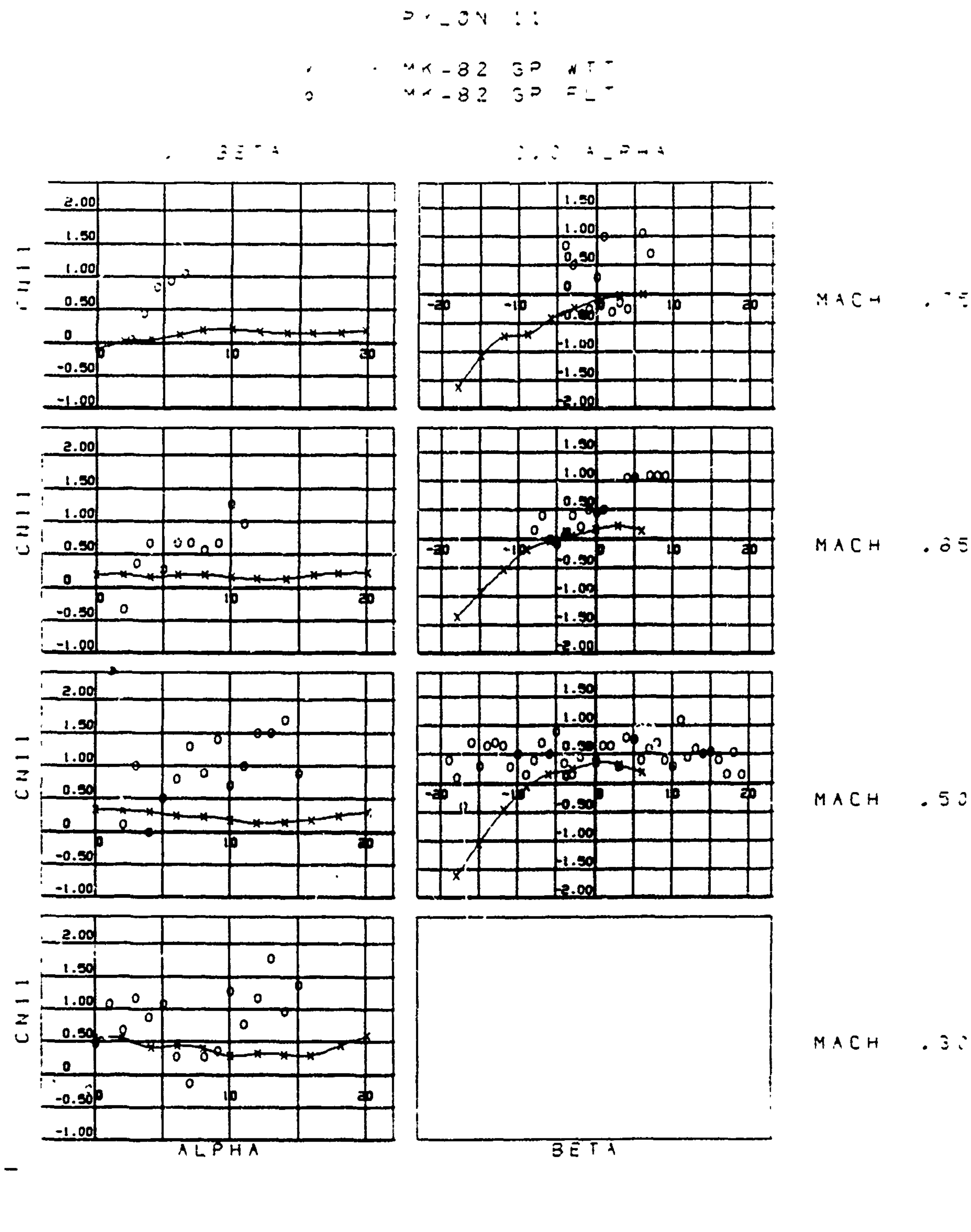


Figure 153. Wind Tunnel Versus 80% Loads Flight Test,
Pylon 11, MK-82 GP, CN

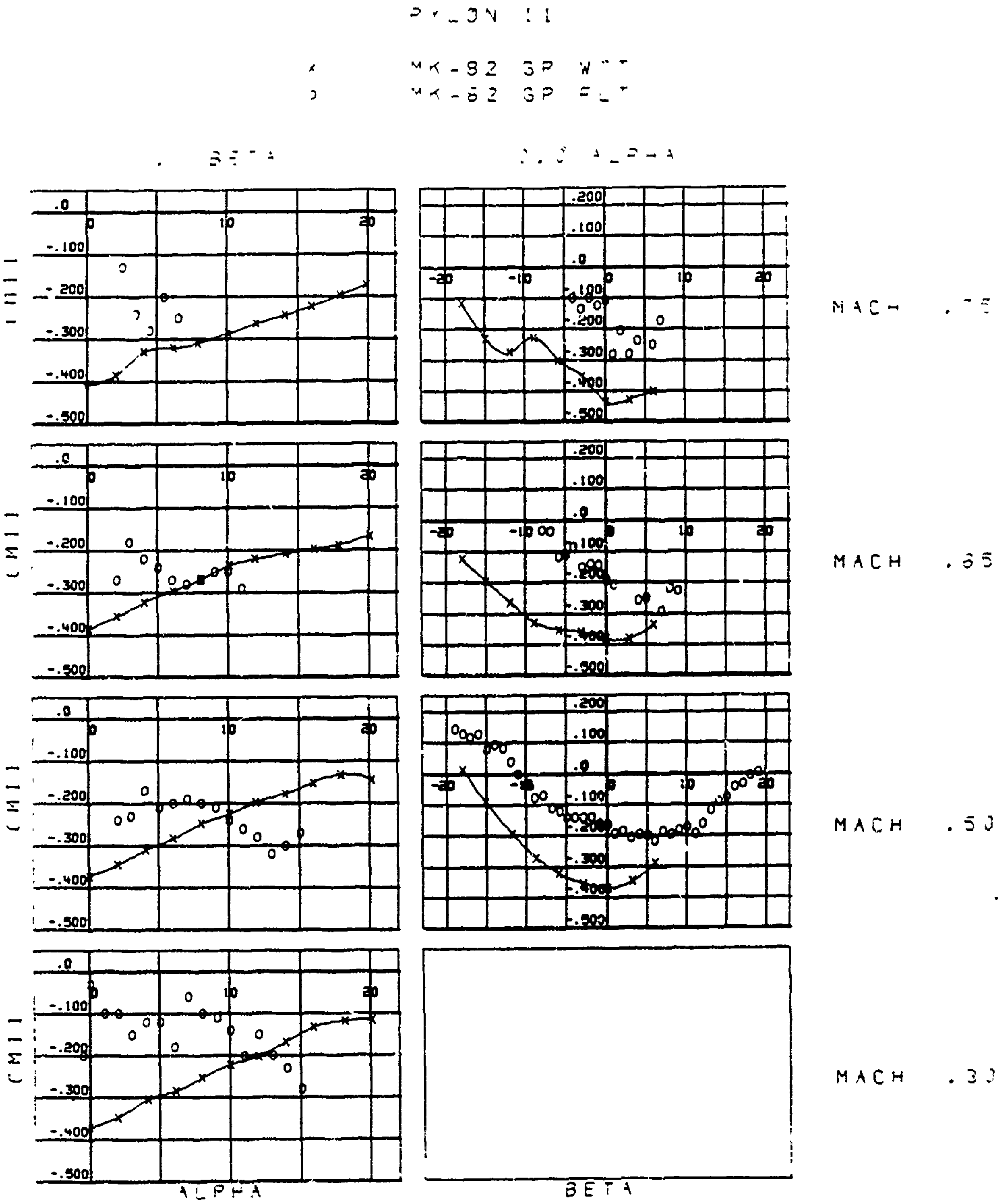


Figure 154. Wind Tunnel Versus 80% Loads Flight Test, Pylon 11, MK-82 GP, CM

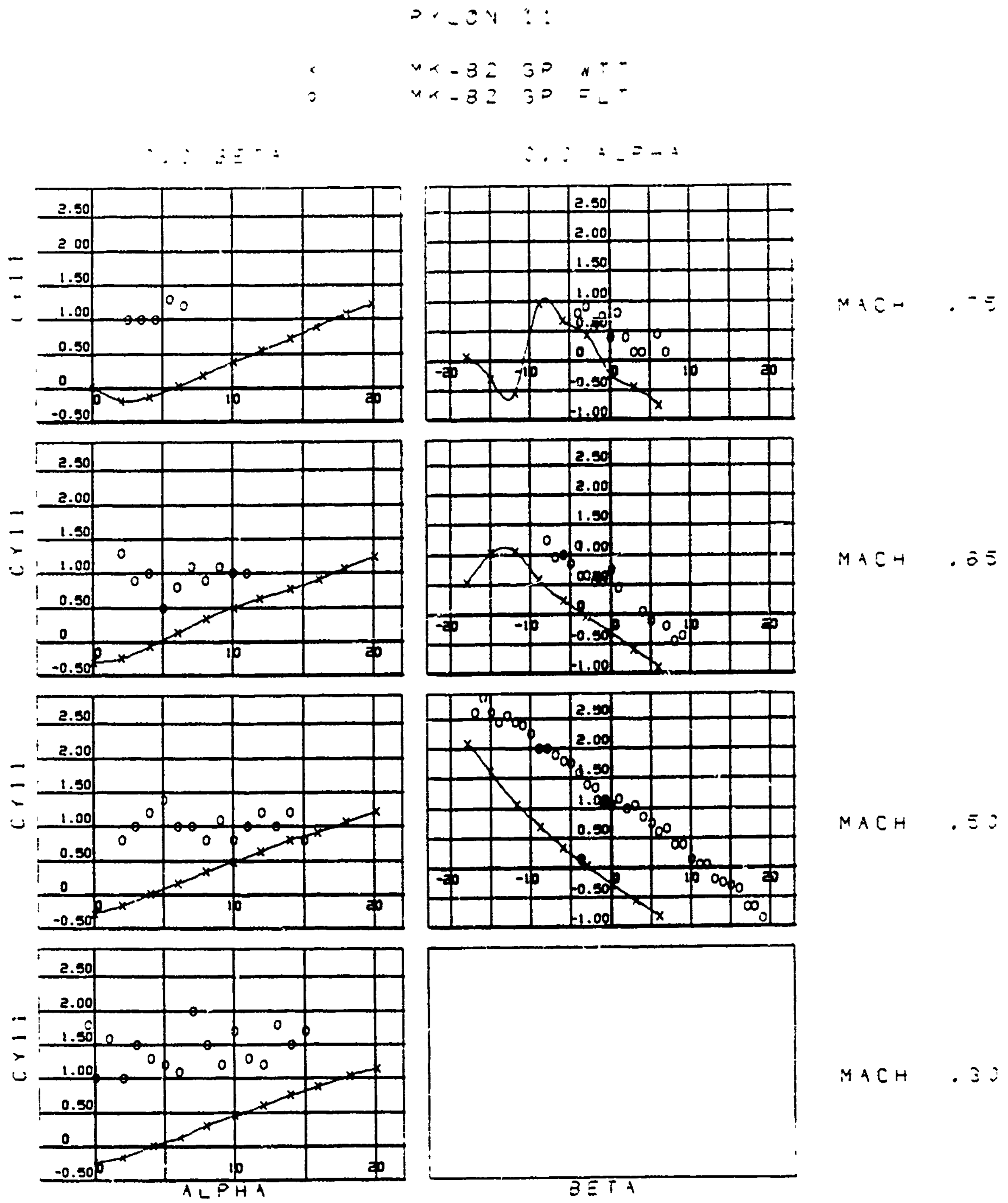


Figure 155. Wind Tunnel Versus 80% Loads Flight Test, Pylon 11, MK-82 GP, CY

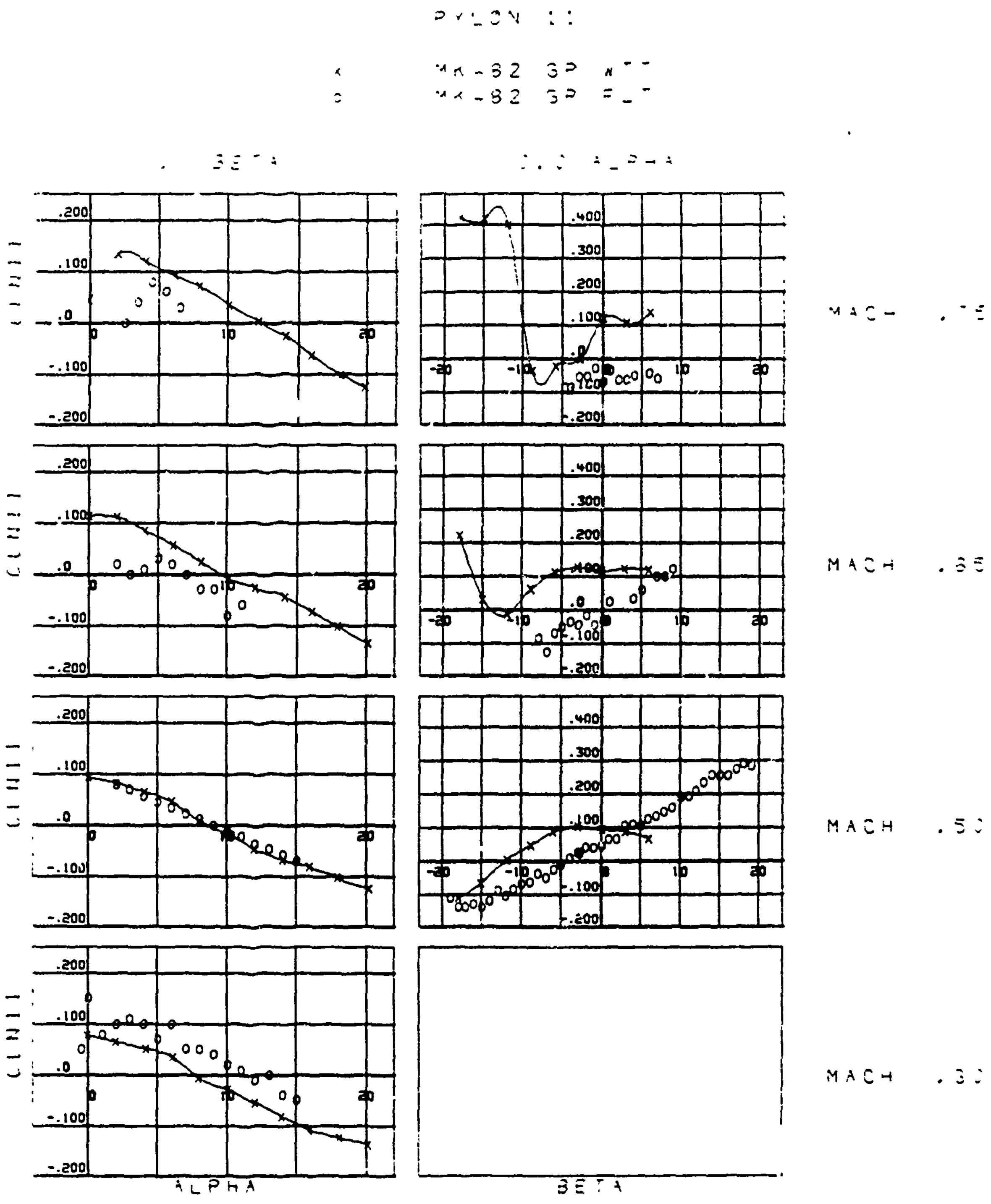


Figure 156. Wind Tunnel Versus 80% Loads Flight Test, Pylon 11, MK-82 GP, CLN

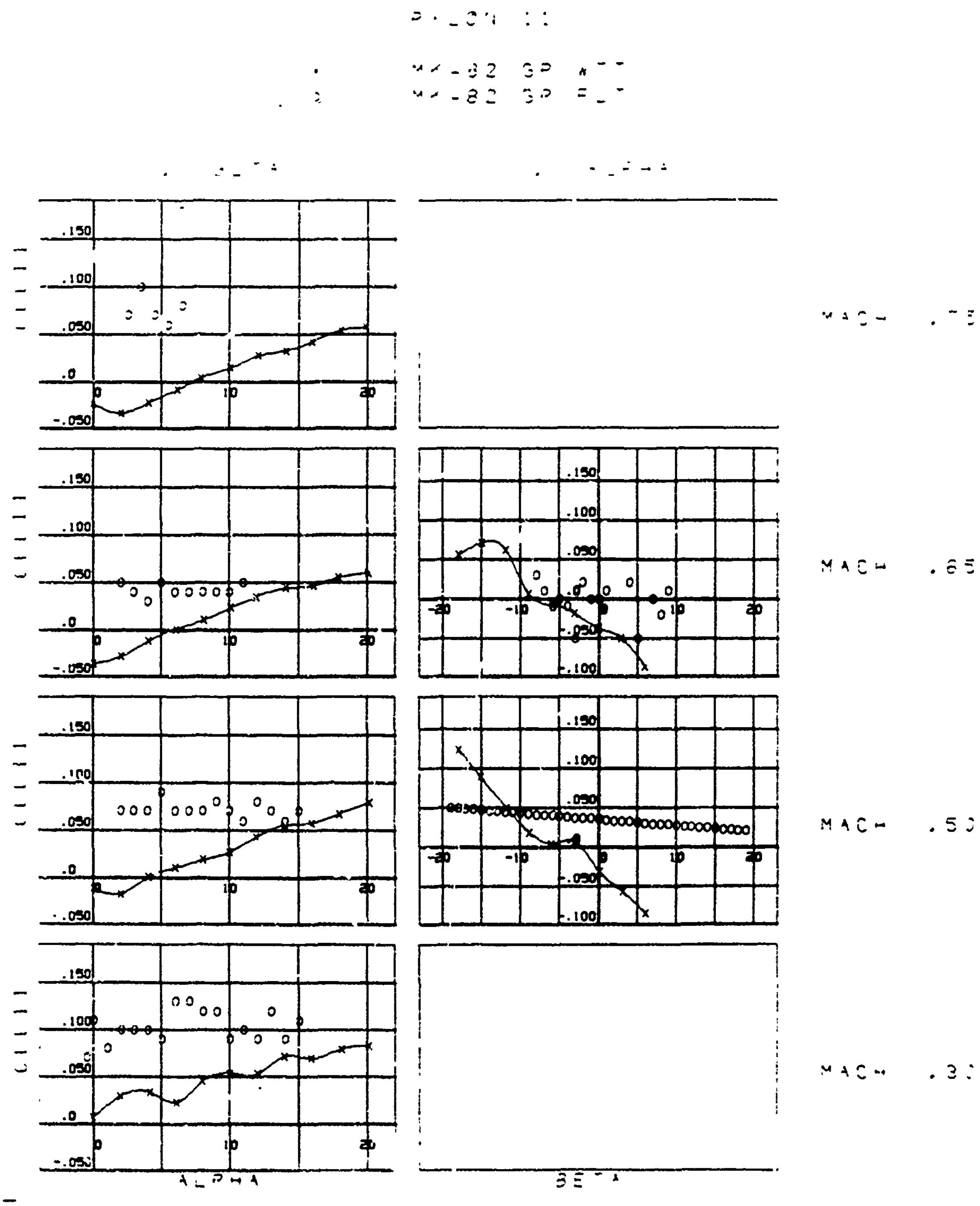


Figure 157. Wind Tunnel Versus 30% Loads Flight Test, Pylon 11, MK-82 GP, CLL

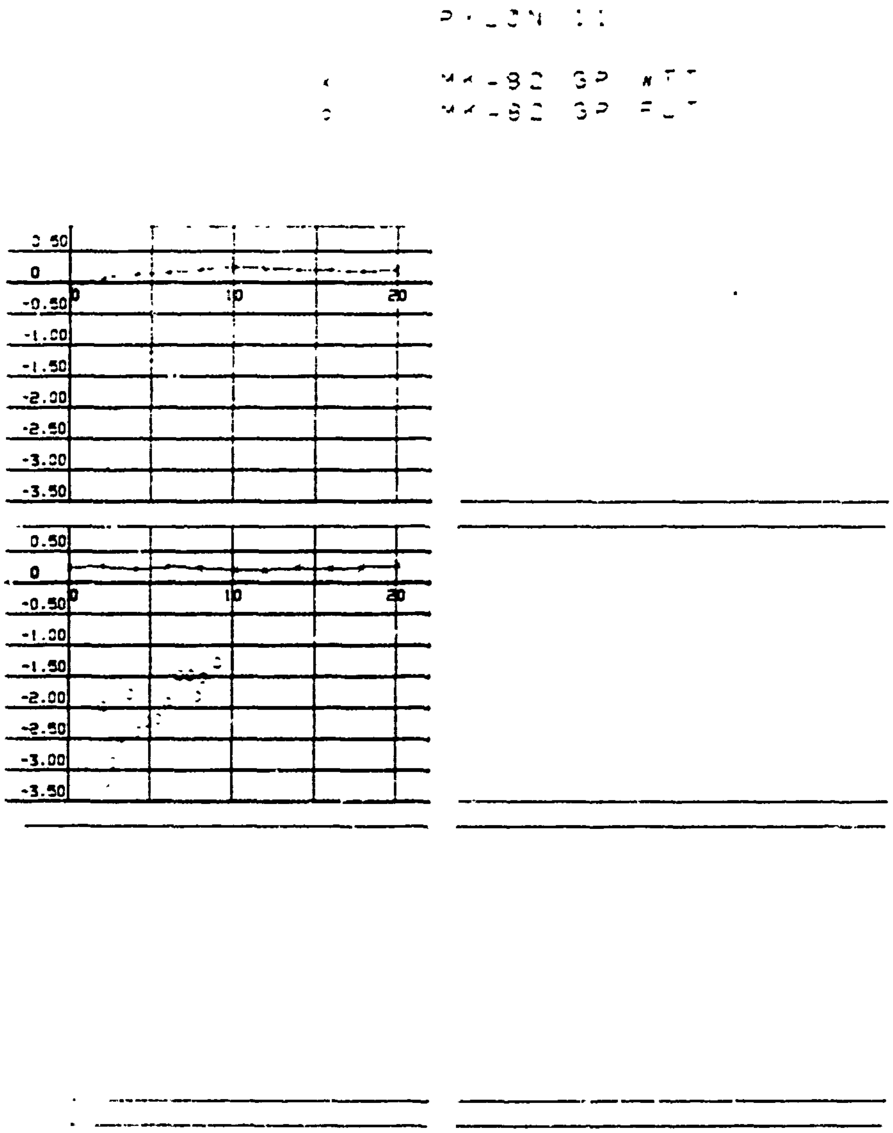


Figure 158. Wind Tunnel Versus 100% Loads Flight Test,
Pylon 11, MK-82 GP, CN

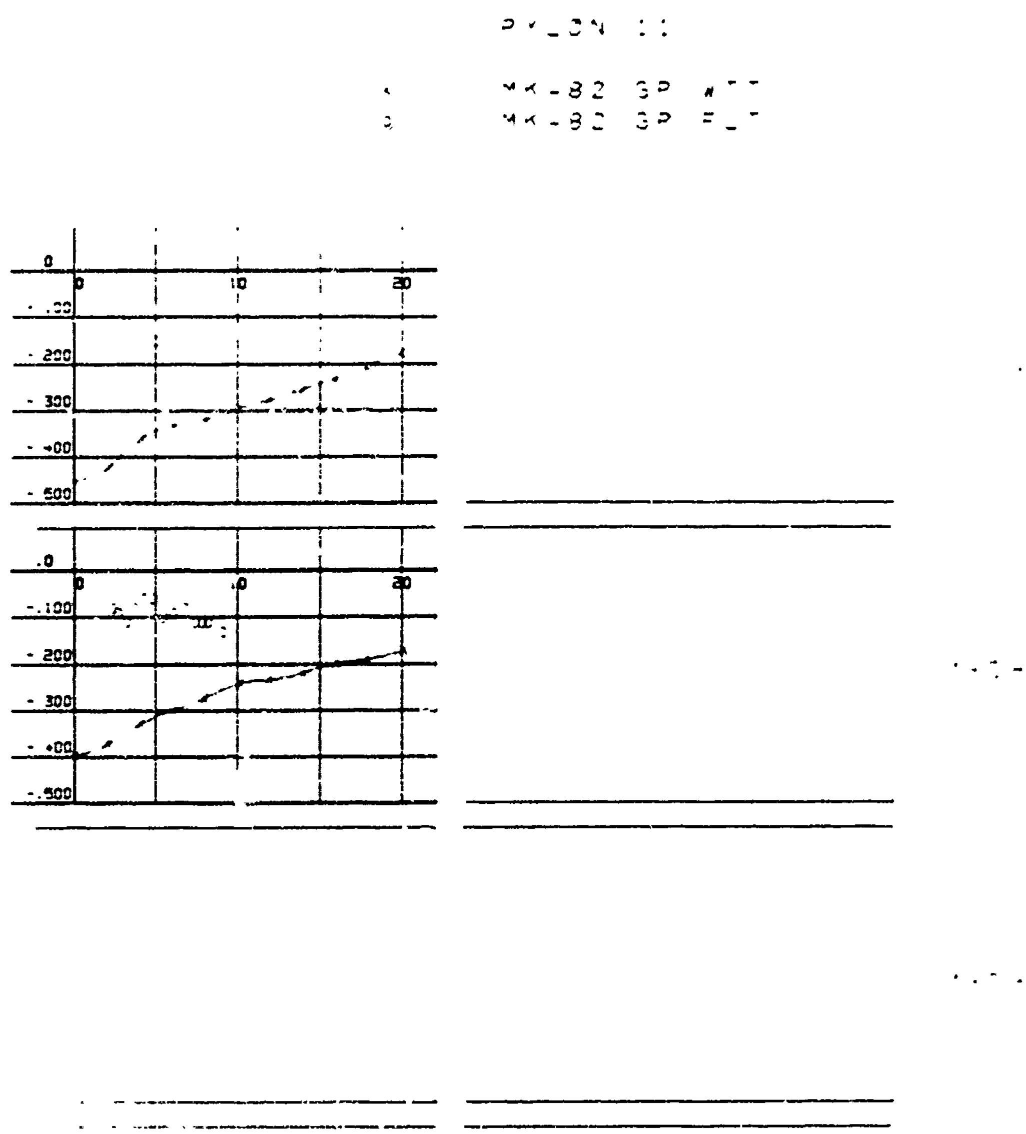


Figure 159. Wind Tunnel Versus 100% Loads Flight Test, Pylon 11, MK-82 GP, CM

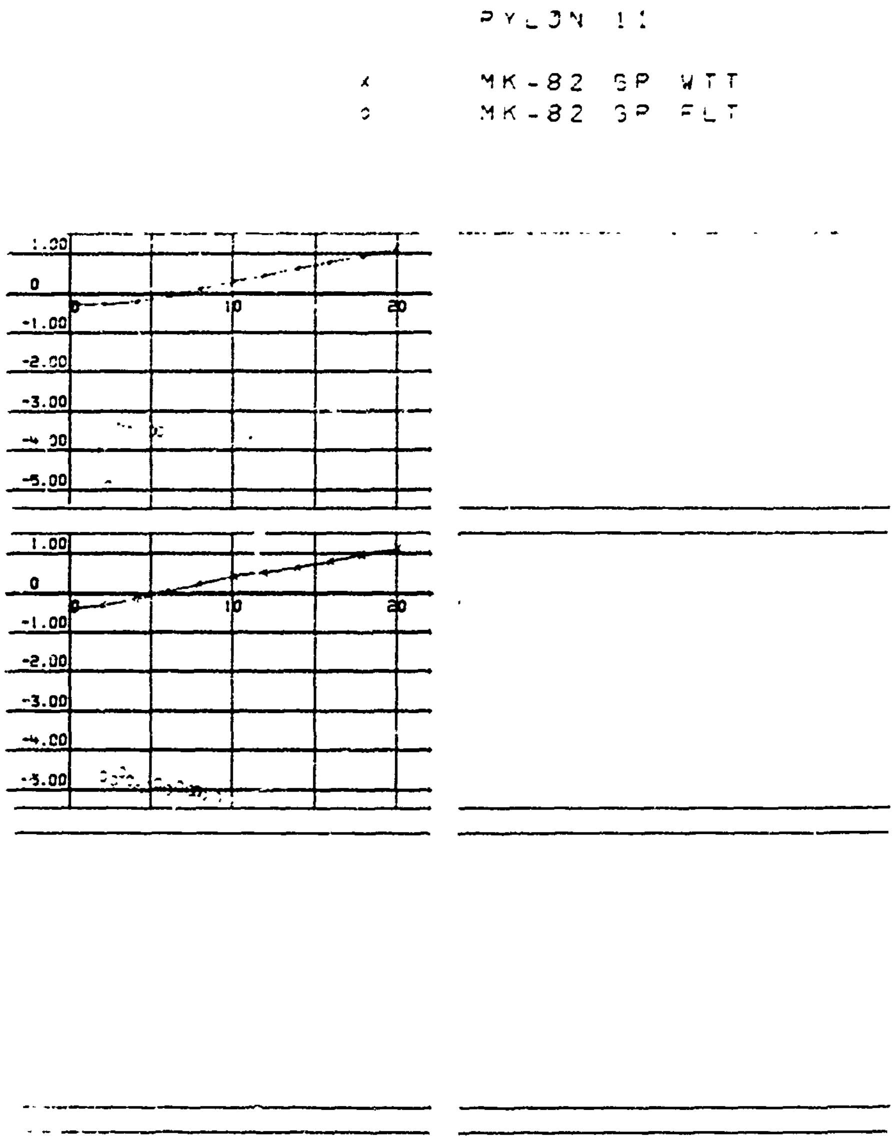


Figure 160. Wind Tunnel Versus 100% Loads Flight Test, Pylon 11, MK-82 GP, CY

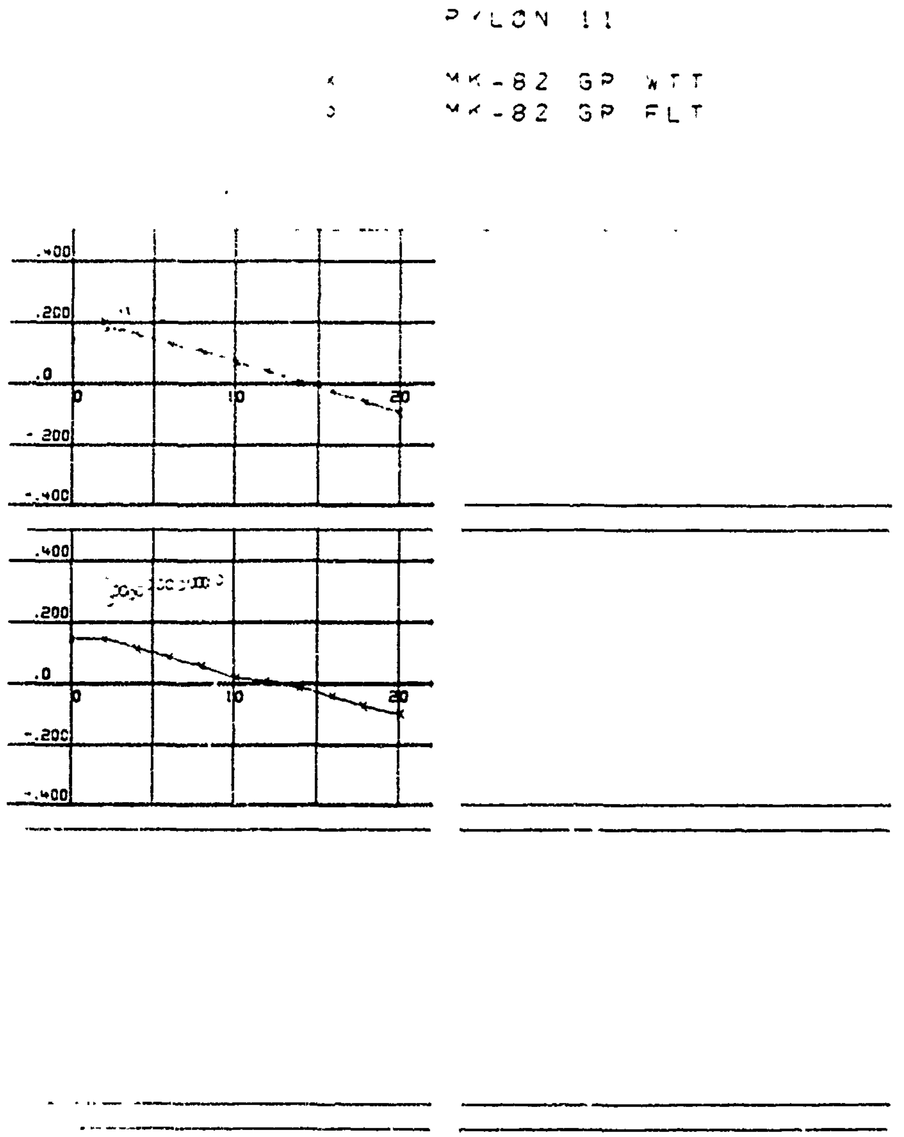


Figure 161. Wind Tunnel Versus 100% Loads Flight Test, Pylon 11, MK-82 GP, CLN

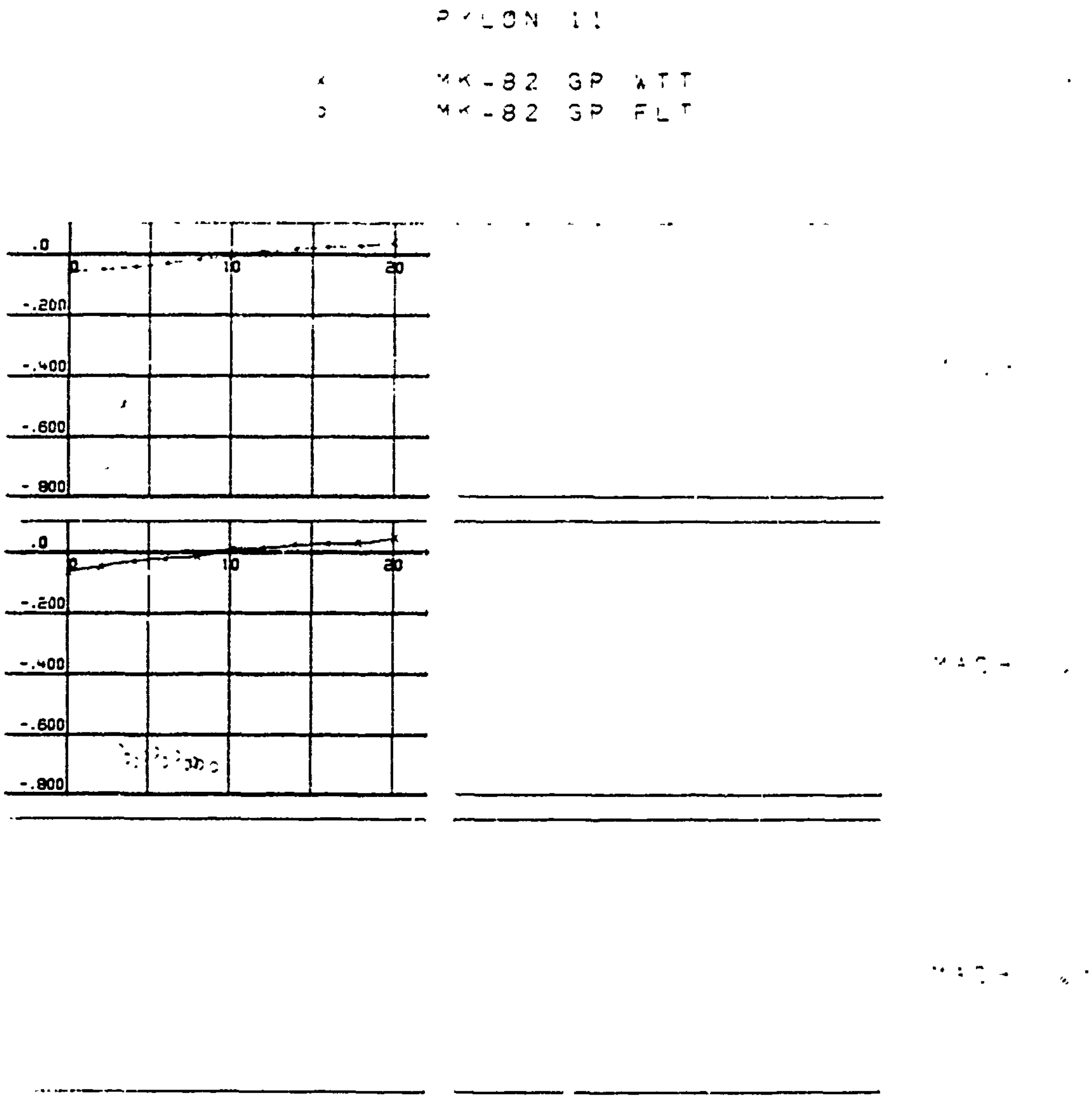


Figure 162. Wind Tunnel Versus 100% Loads Flight Test, Pylon 11, MK-82 GP, CLL

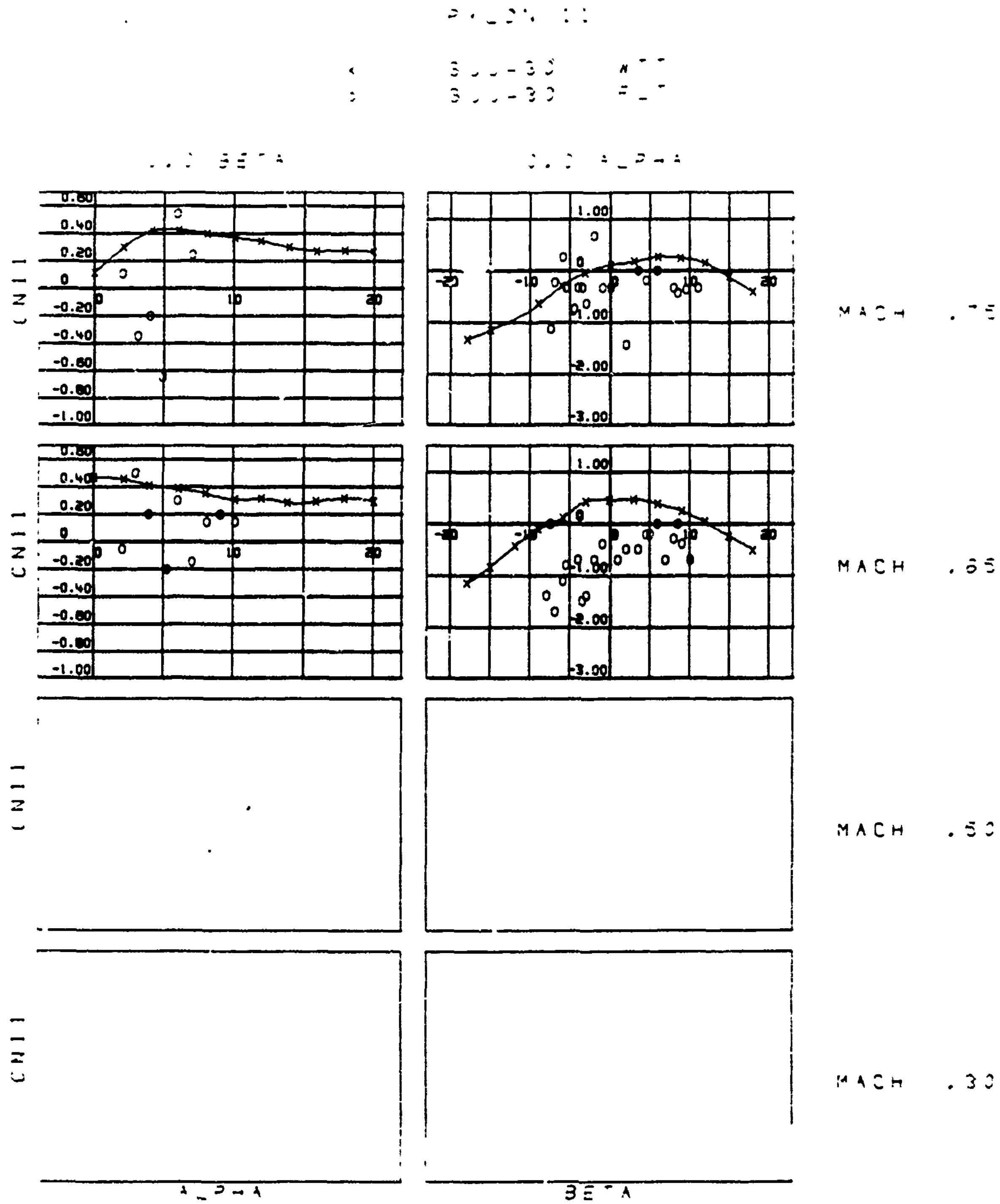


Figure 163. Wind Tunnel Versus 100% Loads Flight Test,
Pylon 11, SUU-30, CN

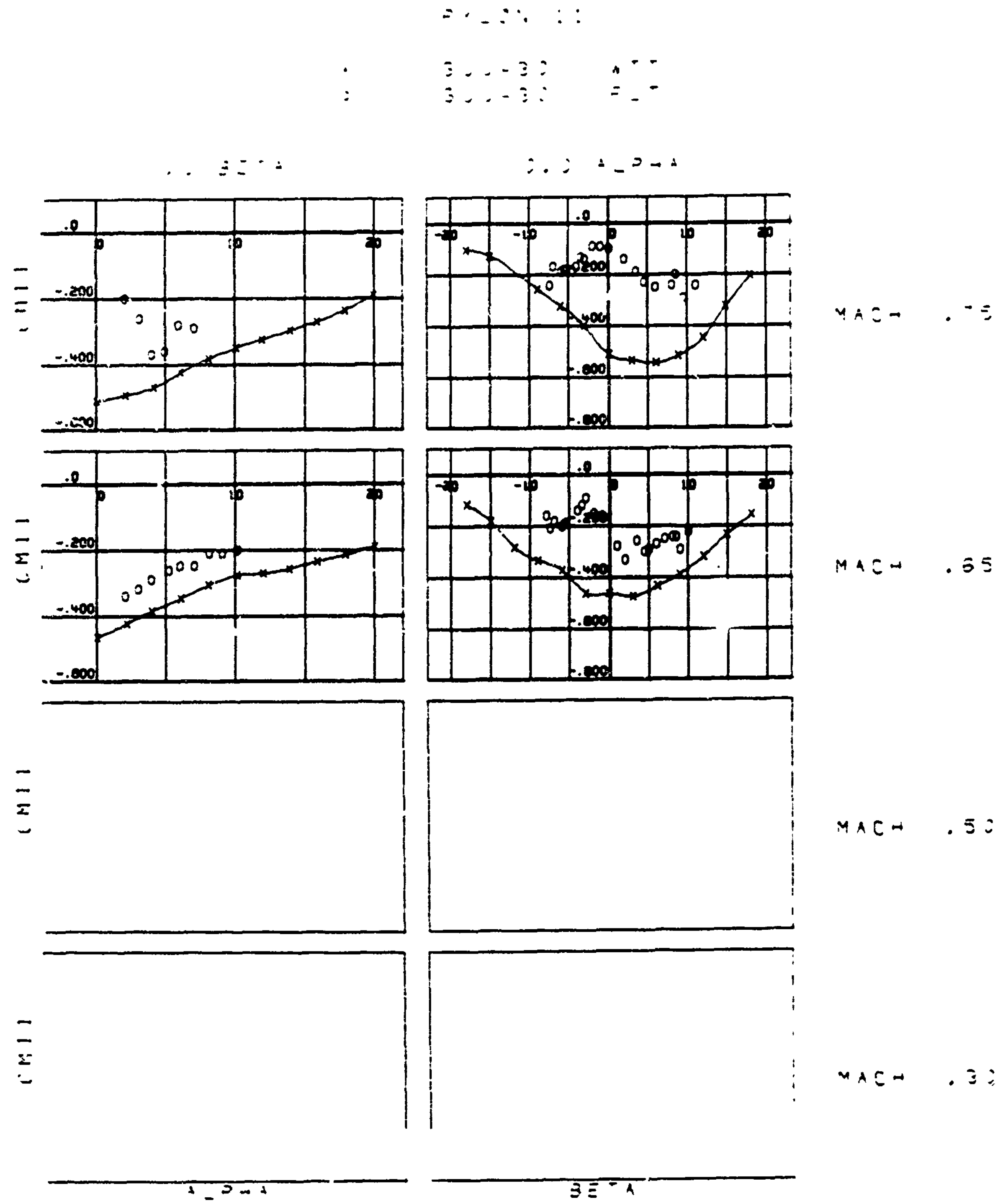


Figure 164. Wind Tunnel Versus 100% Loads Flight Test,
Pylon 11, SUU-30, CM

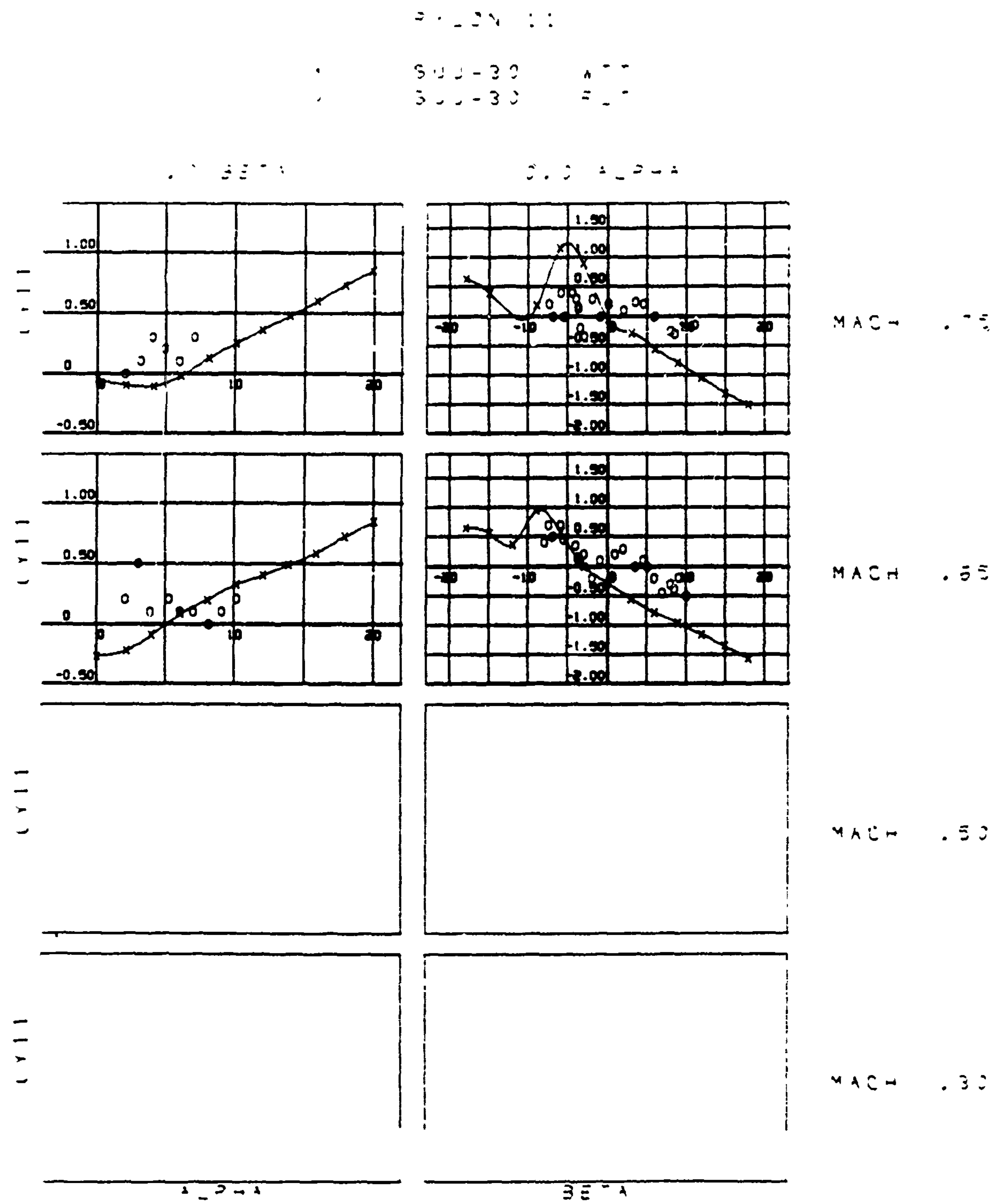


Figure 165. Wind Tunnel Versus 100% Loads Flight Test, Pylon 11, SUU-30, CY

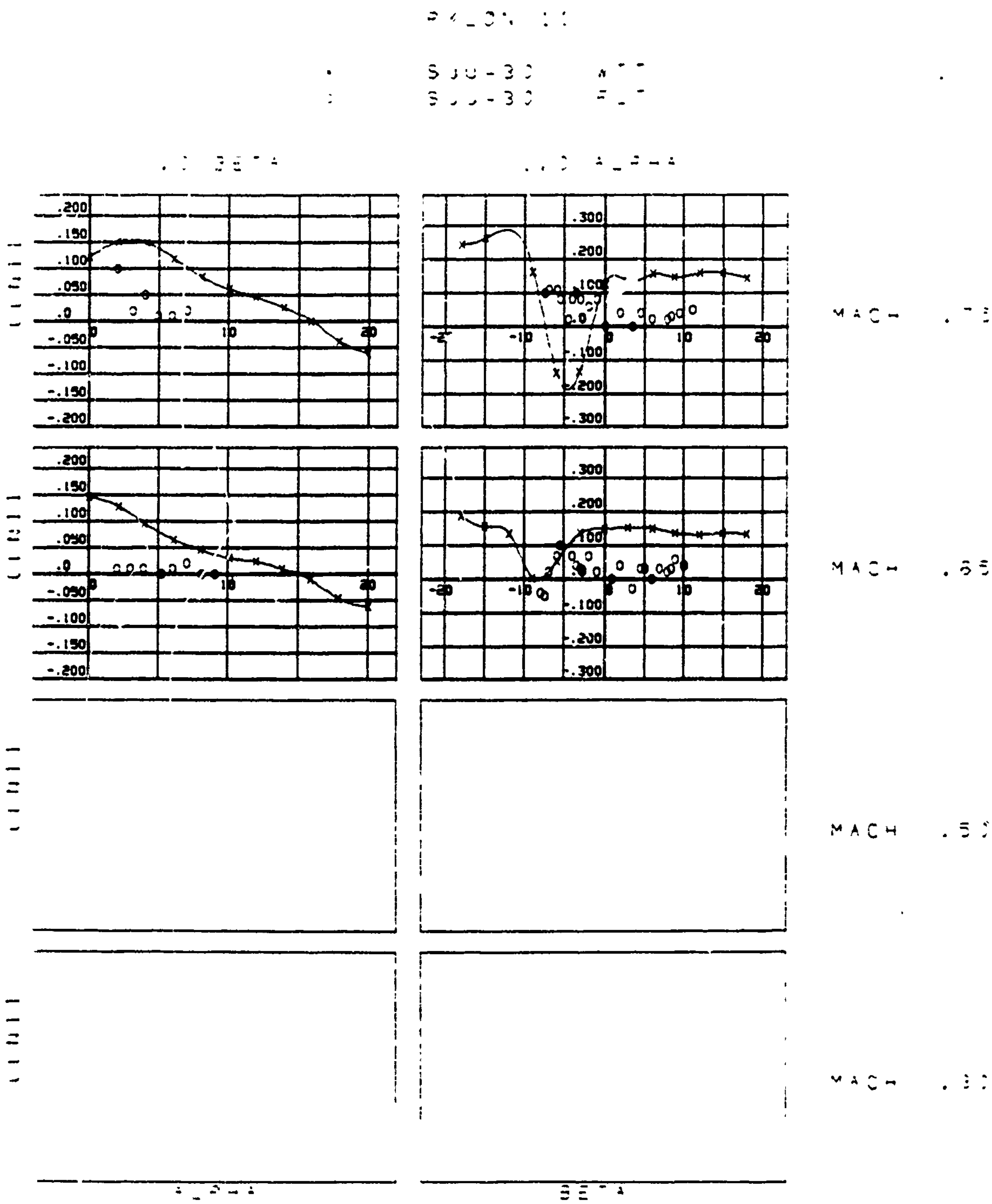


Figure 166. Wind Tunnel Versus 100% Loads Flight Test, Pylon 11, SUU-30, CLN

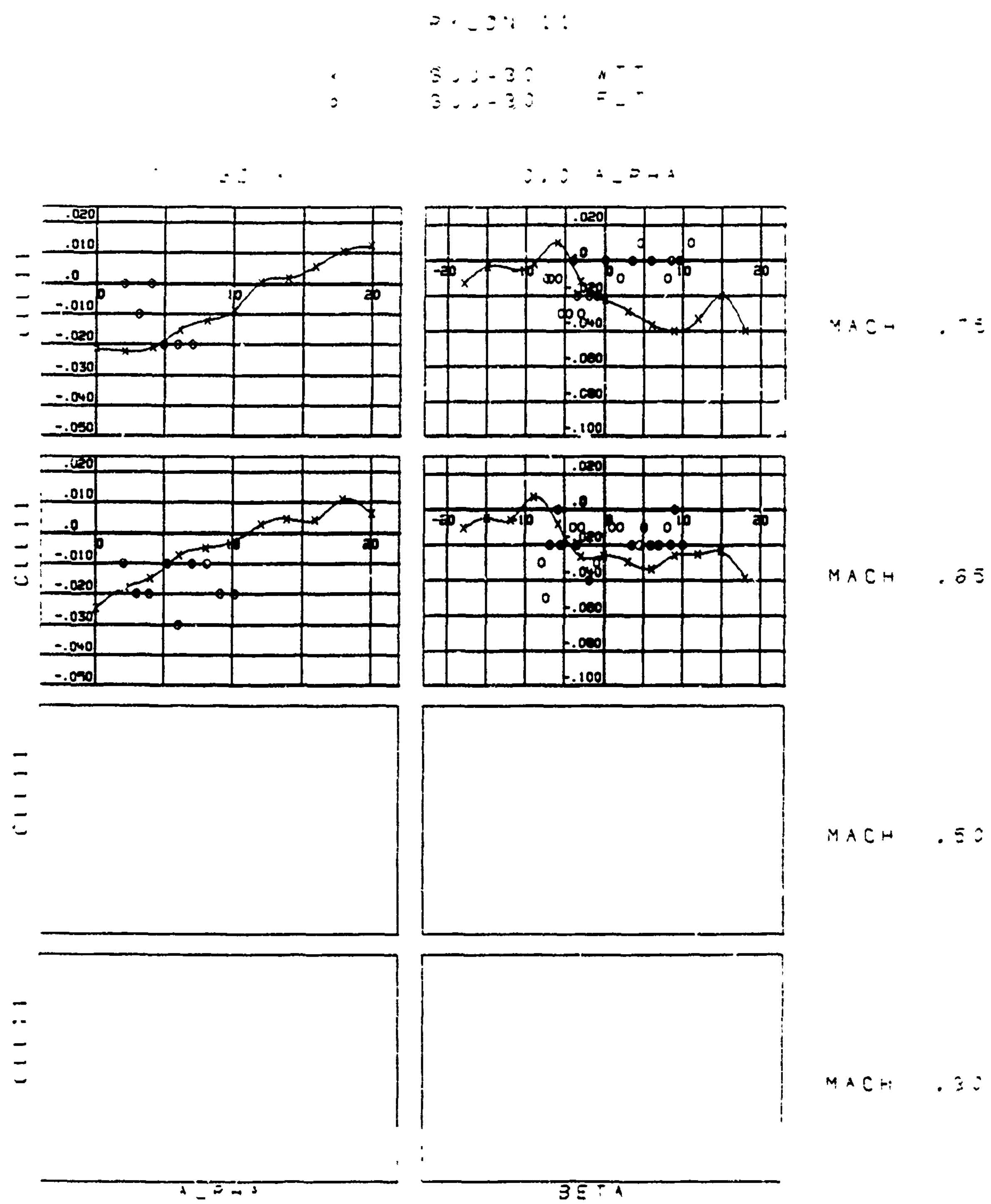


Figure 167. Wind Tunnel Versus 100% Loads Flight Test,
Pylon 11, SUU-30, CLL

REFERENCES

1. Lijewski, L. E., "Comparison of Store Airloads from 5.0 and 7.5 Percent F-15 Wind Tunnel Tests". AFATL-TR-78-135, November 1978. (U)

2. Gomillion, G. R., "Comparison of Wind Tunnel Aerodynamic Data on 1/9 and 1/20 Scale F-16 Aircraft, Store, and Store-Ejector Rack Models", AEDC-TR-79-15, (AFATL-TR-79-13), August 1979. (U)

3. Test Facilities Handbook (Eleventh Edition). "Propulsion Wind Tunnel Test Facility, Vol 4." Arnold Engineering Development Center, June 1979. (U)

4. Shadow, T.O., "Documentation of the A-10 Carriage Loads Test", AEDC-TSR-78-P9, July 1978. (U)

5. Engineering Flight Test Report, "A-10A Aircraft Flight [illegible] Demonstration External Store Loads Flight Test Program", Fairchild Republi[illegible] [illegible]pany Report FT160RFS02, Part 2, February 1978. (U)

6. Lijewski, L. E., "Documentation Data of A-10 Flight and Wind Tunnel Tests Comparison Analysis", Aircraft Compatibility Branch Aero Memo 81-20, June 1981.

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APPENDIX A

WIND TUNNEL TESTS, SAMPLE PLOTS

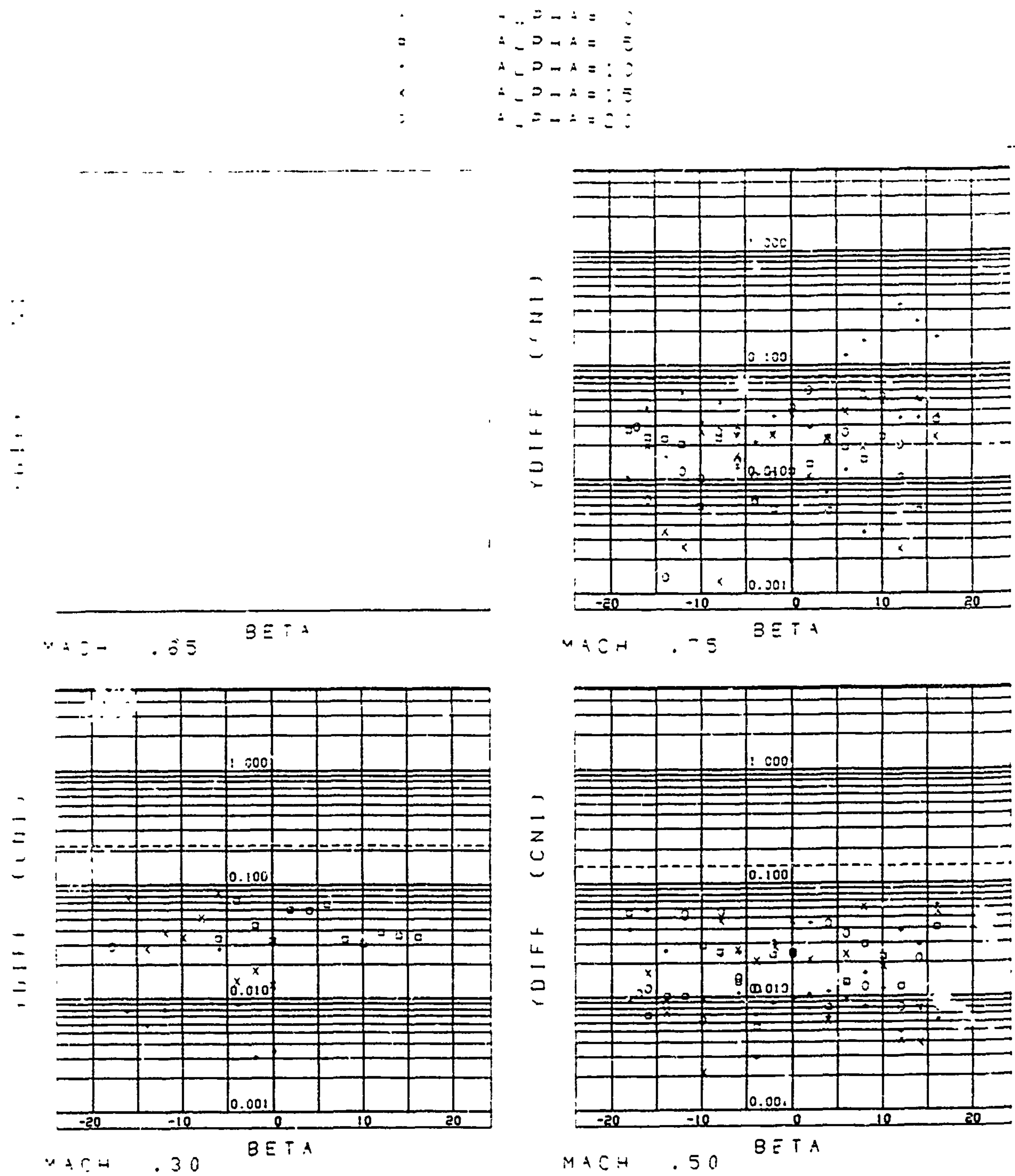

Figure A-1. Hysteresis YDIFF Data, CN, Pylon 1, Configuration 30

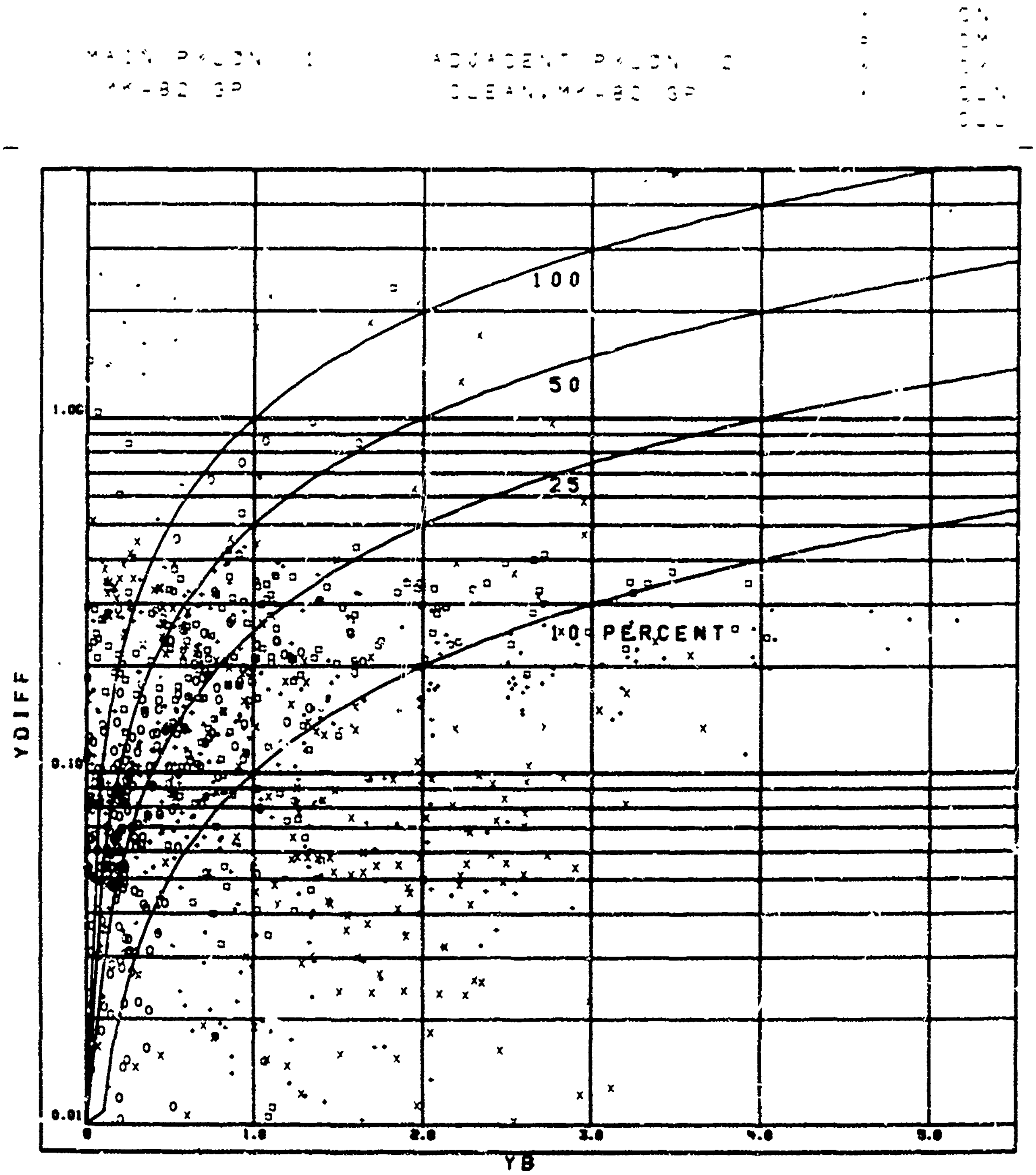

Figure A-2. YDIFF Versus YB Summary Plot, Cases 1, 5

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